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VOLUME FIVE

The AMERICAN CYCLOPEDIA of the AUTOMOBILE
or, MOTOR CARS and MOTORING SELF-TAUGHT

A WORK OF REFERENCE & SELF INSTRUCTION, COVERING the ENTIRE FIELD OF AUTOMOBILING. FOR OWNERS, REPAIR MEN, OPERATORS, INTENDING PURCHASERS & ALL OTHERS INTERESTED IN MOTORING OR the AUTOMOBILE TRADE

Profusely Illustrated

THE TEXT INCLUDES HUNDREDS of HINTS ON MOTOR & OTHER TROUBLES & THEIR REMEDIES .... ROADSIDE REPAIRS, ETC. STUDY HELPS & a COMPLETE CATECHISM on IMPORTANT SUBJECTS .. A HISTORY of the AUTOMOBILE from Earliest Days

Complete in Six Volumes

....BY....
THOMAS H. RUSSELL, LL.B., M.E.
:: AND ::
CHARLES P. ROOT, former Editor of *Motor Age*
Assisted by a Corps of Experts

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Fig. 1 shows the inner tube nipped under one corner of the beaded edge of the tire.

Fig. 2 shows how the inner tube may be nipped between the side of the tire bolt and the inside of the bead of the tire.

Fig. 3 shows how it may be nipped similarly between the head of the valve and the inside of the beaded edge of the tire.

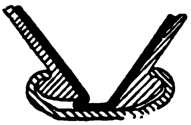


Fig 1

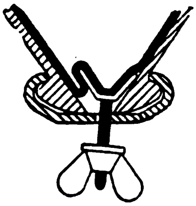


Fig. 2.

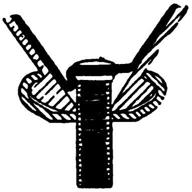


Fig 3.

In all these cases considerable injury will be done to the inner tube.

A nip may easily be caused through the stem of a tire bolt being bent. Under such circumstances, it may stick in the felloe, or, owing to its being bent, the tube may slip under the head, resulting in a small burst. A bent bolt, therefore, should always be replaced with a new one. If the leather on the head is creased and cannot be smoothed out, a new bolt should be substituted. The butterfly nut should be tightened by hand and not with pincers, and on no account should the bolt or valve be hammered unless with a block of wood between as a buffer, and then only as a last resource.

It is a wise precaution, before inserting the tube, to see that the nut holding the valve seat in place on the tube is screwed up tight, as it sometimes shakes loose while in the tire bag, owing to vibration.

7. **Repairing a Puncture**—It is always advisable to carry spare air tubes, and to insert one in place of the punctured one. The puncture can then be repaired at leisure, preferably with the aid of a vulcanizer; but if a tube is not available, a fairly satisfactory job can be made with a rubber patch and solution as follows: Carefully rub the air tube for a considerable space round the puncture with sandpaper, then clean

with gasolene, and while still damp scrape with the blade of a knife held edge downward. A rubber patch of suitable size should be treated similarly. Next spread with the fingers a thin layer of solution over the patch and the prepared portion of the air tube. If it is at all thick, or there are any blobs, the air will force its way out when the tire has been running for a little while, and has become hot. After spreading the solution, lay the patch and air tube aside to dry, and, after waiting for fifteen or twenty minutes, touch the surface lightly with the finger. If either patch or air tube adheres, the solution is not yet dry enough, and the operator should wait until it becomes so dry that it does not stick to the finger. Then apply the patch carefully, smoothing it into position until it lies quite flat, and without creases. Roll it under pressure with the chalk cylinder, and if possible put it between two flat and heavy surfaces for a few minutes. The patch should be well sprinkled with chalk before the tube is replaced in the casing, shoe or cover.

It is, however, far safer to repair the puncture in the motor house at one's leisure. The solution on patch and tube should be left to dry for several hours, or even for an entire night. The patch should then be rolled into position, and the repaired portion, having been placed between two boards, should be left in the vise under moderate pressure for an hour.

A vulcanized repair is, of course, more reliable, and can easily be effected by following the printed directions in the booklets issued by the manufacturers of vulcanizers.

The following system of effecting a roadside repair is successful if properly carried out: Thoroughly clean both patch and tube with sandpaper, and apply three coats of solution to both, allowing the two first coats to become quite dry before putting on the next. When the third coat has become almost dry, pass a brush or pad of cloth thoroughly wet with sulphureted hydrogen over the solution on the inner tube, and press the patch instantly in its place, when the repair is complete and the tube can be used at once. The most important point in this method of repair is that the patch must be placed on the tube within ten seconds from the application of the sulphureted hydrogen, as otherwise it will not be successful.

Wheel rims should occasionally be examined for dents or bulges, as these defects cause the edges of the rim to have a decided cutting action on the beaded edge of the casing. Especially is this the case when the car has been driven on a flat tire, as the rim is then more liable to damage. If the edge has been flattened it is best to have it attended to by a competent man, but bulges, on the other hand, can be gently tapped back into shape, care being taken not to mark the metal with the hammer. Afterward, the part which has been operated upon should be touched up with paint and well varnished, otherwise the rim will rust, causing injury to the casing.

If possible, avoid driving on a deflated tire; it will ruin both cover and air tube, and may so dent the rim as to render the fitting of a new cover difficult, and when fitted, to set up internal wear. If there is no spare cover on board the car and the injury is beyond roadside repair, remove the air tube, and while one side of the cover is out of the rim, stuff the inside with rope, felt, or such like. Then carefully replace the cover in the usual way, and screw home the butterfly nuts firmly.

A driver once made a most effective temporary repair in the following way: Securing some rope, he cut it so as to somewhat exceed in length the circumference of the tire, and then formed a loop on one end. He next procured a quantity of felt, and bound it neatly round the rope, until the bulk was sufficient to make a comparatively tight fit inside the cover. This makeshift was then laid on the rim, the end of the rope placed through the loop, and having been pulled taut, was secured. Then the cover was replaced, and the tire was found to act admirably. Of course, it was "dead," and there was a distinct bump at the point where the joint in the rope occurred. It was, however, almost as comfortable as a solid tire, and protected the rim perfectly. For a comparatively short distance a car might be so driven without even causing injury to the cover.

Another system which can be recommended is to wholly remove air tube and cover and twist a length of rope round and round the rim, splicing the ends and wiring in position.

Some types of tires depend altogether on mechanical fastening. To detach these is a plain, straightforward job. In replacing them, the same care should be taken to prevent the tube from being nipped. It is also necessary that when an annular band is used it should be replaced in the same position, and to insure this it is well to mark both the band and the rim. In every case the special booklets describing these tires should be procured.

8. **Repairing Casings**—This is essentially a case where prevention is better than cure. A burst is caused, in the great majority of cases, by wet penetrating through a cut in the rubber and gradually rotting the fabric; or through the strands of the fabric getting cut by the sawing action set up between them. As regards the first cause of failure, the remedy is to repair the cuts as soon as they appear, in the manner hereinafter described. As regards the second cause of failure, it is generally due to the tires being used too slack, thus causing excessive flexion.

Whatever the cause, an impending burst is generally notified by a boil or slight swelling at the weak spot, and the moment such becomes apparent the outer edge of the cover should be removed for the purpose of inspecting the fabric. If it is found that the fabric is failing, the driver should affix a gaiter over the outer cover at the weak spot to enable him to get home and carry out a permanent repair. If a burst actually occurs, a piece of canvas should be cut long enough to extend about eight inches beyond the burst, and wide enough when bent round in a tube to considerably exceed the circumference of the tire. This canvas should be inserted between one edge of the cover and the rim. It should be pulled over the air tube as it lies flat on the rim, and then should be pulled out under the other edge of the cover. The canvas should next be manipulated until it rests snugly and closely inside the cover, forming a close-fitting envelope between it and the air tube, the edges, of course, extending beyond both beaded edges of the cover. The beaded edges should then be replaced in the rim, with the edges of the canvas protruding at both sides, and the tire inflated. If the job is properly performed, the canvas will adapt itself exactly to the size of the tire, and take the strain at the burst portion. If it is a bad fit, that portion where the tire burst is will be either smaller than the rest of the tire or larger. In either case the tire should be deflated, and the operator should try again. It is a wise precaution to fit a sleeve over the faulty portion of the casing for additional security.

To make a permanent repair the use of a vulcanizer is, as a rule, necessary. In most towns there is an expert in the art, who can be relied upon to do the work satisfactorily, or the tire can be sent to the makers. Many automobile owners keep a vulcanizer in their garages, and if the chauffeur is expert it will prove a profitable investment.

If a burst has to be repaired on tour and no vulcanizer is available, a more durable job can be effected as follows: Remove the cover from the rim. Remove all the decayed or faulty portion of the first or innermost layer of fabric; then remove in succession smaller portions of the next layers, reducing the size in proportion until the one next the rubber is reached. Then remove all French chalk or dirt and thoroughly wash the fabric and rubber about the burst with a rag soaked in gasolene. Next cut a piece of rubber to fit the innermost aperture, and also portions of canvas to exactly fit the various apertures in the successive layers of fabric. Solution these patches on both sides and leave to dry for about twenty minutes. Also thoroughly solution the exposed surfaces of the burst, working the solution between the layers of fabric where possible. Now place the rubber patch first in position so as to exclude the wet, and after that the canvas patches in succession. Use pressure to insure firm contact. A rounded wooden block is the best means. To complete the job take a larger piece of canvas of the size and shape recommended when temporarily repairing a burst. Solution one side, and also spread a coat of solution over the existing patches as they rest in place and for several inches on both sides of them. Let the solution dry for twenty minutes, and then place the canvas patch, solutioned side downward, carefully in position, bringing the edges well over the beaded edges of the cover. Avoid creasing, as any unevenness will set up friction and chafe the air tube. Scatter French chalk over the repair and replace the casing.

In some cases boils are superficial, being caused by dirt and grit penetrating through a small cut in the cover and working their way between the rubber and the fabric. These should be attended to at once. The grit should first be carefully removed by a blunt instrument—the flattened end of a match will do. The fabric and rubber where they have parted company should then be cleaned with gasolene or benzene as far as possible, and solution should be carefully worked in. It would be advisable to allow the solution to stand for a few minutes to become tacky. The rubber should then be firmly pressed downwards and tape wound round the tire so as to press the rubber at the damaged spot firmly against the fabric. The tape should be left in position for several hours, during which period the car should not be used.

As already mentioned, cuts in the rubber of the outer cover, even if only nail holes, should be repaired at once, if possible on the very day they are discovered. The only really effective method is by vulcanizing, and every motorist should carry one of the excellent little car vulcanizers now on the market. Full instructions are supplied with the vulcanizers.

Those who, from mistaken ideas of economy, do not invest in this useful appliance will have to try one of the many special preparations now on the market. We will describe the method of application. Clean all dirt out of the cut and scrape both sides with the blade of a knife, if necessary trimming the jagged edges. Then wash thoroughly with gasolene or benzene. Next fill the cut with a layer of the preparation, and after allowing fifteen minutes for it to dry, add successive layers until the surface is quite flush. The repair should be left for twenty-four hours to set. If properly applied, such a repair is generally effective, but cannot be relied upon absolutely.

9. **Valve Troubles**—The non-return valve of a pneumatic automobile tire is in principle and general construction almost the same as the valve of a bicycle tire, with which it is presumed our readers are acquainted.

The Michelin type of valve which is now fitted to motor-car tires, consists of a hollow stem A into which fits the valve proper, B. This consists of a hollow spindle, having at its top end a conical seat O. Inside the spindle is loosely fitted a small wire or pin J, having at its top end a cone of vulcanized rubber. This cone forms a valve, and fits into the conical seating O in the top end of the hollow spindle.

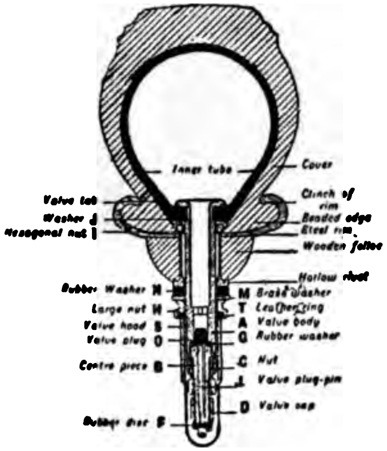


FIG. 4.—THE MICHELIN VALVE.

On the hollow spindle is a shoulder, against which is a rubber washer G. The spindle is kept pressed down into the valve stem by a screwed gland C, and an air-tight joint is made between the rubber washer and a shoulder inside the valve stem. The outside end of the spindle is threaded to take a pump connection.

Leaky valves occasionally cause trouble. In the case of the Michelin type, which is in very general use, there are four points which need careful attention.

First, the rubber plug O (which, we might mention, is not absolutely air-tight until the cap D has been screwed on). Should there be a definite leak, the rubber plug, its pin, and its seating should be cleaned, a little French chalk first having been rubbed on the operator's hands. If the plug is actually damaged, it should be replaced with a new one. The rubber disk F in the bottom of the screw cap D is intended to provide against small leakages at O. If it is damaged, it should be replaced. If a spare disk is not at hand, a well-fitted ring of leather or cloth soaked in grease will prove effective. Sometimes the air may escape at the rubber ring or washer G. This is due to the nut C holding the center piece B and forming a rubber joint between the valve stem and the air tube, not being screwed down tightly enough so as to compress the rubber ring G between the center piece B and the valve body A. If the rubber in the ring G is perished, it should be at once replaced. A ring of leather or thread smeared with tallow will do in an emergency. Sometimes the nut I may have worked loose, which may often cause an escape of air; it should be screwed up, but not too tightly, or it may split the air tube. The best way to definitely detect a leak in the valve is to turn the wheel until the valve cap points downward, and then immerse the valve in a glass of water. If air bubbles rise, the valve is leaking. The valve parts should be tightened by hand, as they do not require great pressure.

Care in seeing that the rubber cones and washers are in good condition and not perished, and that no dirt or grit or other foreign matter gets into the valve, is all that is necessary in keeping the valves in order. On no account should any oil be used near any tire valve. It attracts dirt and grit, and very soon perishes the rubber and causes leaks.

10. **The Actuating Levers**—A typical set of tire tools consists of the following articles:

Three levers for removing and replacing bead.

Forked manipulator for moving bead out of the way when removing or replacing valve or security bolts.

The manipulator consists of a forked lever A (Fig. 5) and two strut pieces, one shown at B, hinged at C, and with shoulders D and E, which bear against the clinch of the rim and the bead of the tire respectively. In Fig. 5 the manipulator has been inserted under the bead of the tire.

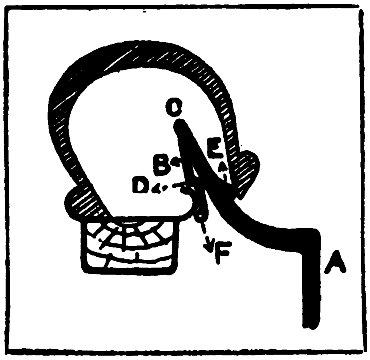


Fig. 5.—A Tire Manipulator.

Fig. 6 (a photographic illustration on another page) shows the manipulator after having been inserted under the edge of the cover, and pushed home until the shoulders D, D have found their seating on the edge of the rim. It will be noticed that F, F are the strut pieces hinged at C, while the shoulders E, E, acting against the bead of the outer cover, force it upwards as the lever handle is raised. The manipulator is now in the correct position for fitting the valve or security bolt, and in this illustration the "raison d'etre" of the appliance will be seen. The hinged portion C bears firmly against the bead of the opposite side of the cover, and so prevents it from slipping down and covering the hole. It will be noticed that the shoulders D, D obtain a firm purchase against the edge of the rim, while the shoulders E, E engage with the edge of the cover, which has been removed from the rim, and holds it absolutely out of the way, the leverage obtained being enormous.

Fig. 7 (also a photograph) shows the air valve in the act of being either removed or replaced. To extricate the manipulator, it is only necessary to dip the end of the lever A and pull it out. This manipulator is adaptable to all sizes of tires. For those of 105 millimeters and upward the strut pieces are reversed.

Many other ingenious devices are also made and sold for the purpose of facilitating tire repairs and adjustments, and each type has its own points of advantage. The use of suitable tools for the purpose and the proper application of them prevents damage being done to tires when excessive force is used.

VALVES.

Symptoms: Failure of engine to start.—Diminished Power.—Partial or total loss of compression.—Popping.—Misfires.

Causes—Valves: Pitted, or bearing surface warped.—Bent spindle. —Broken spring.—Weak spring.—Valve stuck through guide getting clogged or spindle bent.—Too little or too much clearance between stem and plunger.—Valve broken.—Dirt under seat.—Foreign matter wedged between valve and seating and causing leakage.—Springs in different cylinders of irregular tension (only in the case of engines with automatically operated inlet valves).

Both the inlet and exhaust valves are apt to get sooty and gummy, especially if the engine is over-lubricated or overheated. This will affect the power of an engine fitted with automatic valves by making them open sluggishly. If about a teaspoonful of kerosene is squirted into each cylinder daily, and the starting handle given a few turns, it will have a very cleansing effect both on valves and piston rings, and will also facilitate starting.

Grinding—Even when every care is exercised, the valves become pitted or worn in process of time, with the result that the compression is affected, and the engine loses power. Grinding is the remedy.

To grind a valve, remove the cross key which passes through its stem, having first raised the hollow cup washer, which prevents the cross key from slipping. This is best done by the aid of a valve spring lifter, many types of which are on

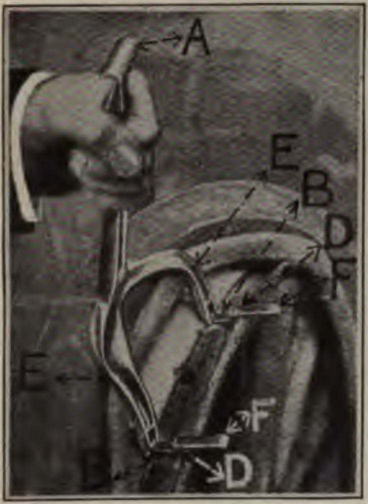


Fig. 6—Clearing Valve Hole or Tire Bolt Hole.

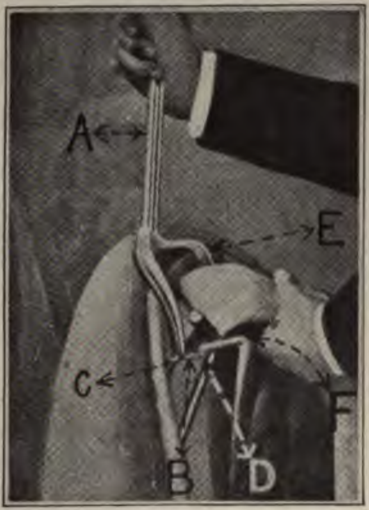
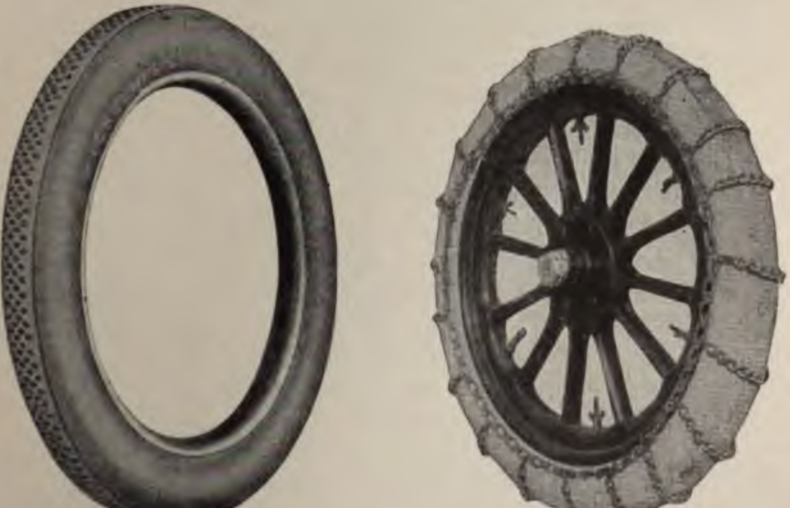


Fig. 7—Valve in Act of Being Removed or Replaced.



Studded Band and Chain Non-Skids.

the market. Then take off the spring and push the stem upward till the head emerges through the valve cover opening.

Much difficulty is often experienced in removing or replacing a valve spring, owing to the necessity for compressing the spring when the cotter, which fills the oblong slot in the valve stem, is being put into position. A very simple way to get over this trouble is to compress the spring in a vise before replacing it, and then secure it in the position assumed by means of a thin wire. The spring can then be easily replaced, and when the cross piece is in place the wire can be cut and the spring will assume its normal position.

Having removed the valve, smear the seating—which is usually part of the cylinder itself—with a mixture of oil and emery powder, or corundum powder, or corn emery. Then replace the valve on its seat. Having plugged up the opening to the combustion chamber with cotton-wool or waste to prevent the emery getting in and scoring the cylinder, proceed to grind the valve on to its seating. Specially made grinding-in tools can be purchased for the purpose, but an ordinary screwdriver will do. The operation is performed by oscillating the valve on its seat, at the same time lifting it occasionally from its seat so that it sits down in a different position. It must be repeated until a true face fit is obtained, and is complete when a clear white line is shown of even width around the valve seat and the valve head.

Then remove the valve and wash out all the emery paste from the entrance to the combustion chamber. Next remove the cotton, and replace the valve, having first thoroughly cleaned the stem and washed it in gasolene. If the stem is dirty, rough, or a very tight fit, polish it with fine emery cloth to prevent all danger of its sticking in the guide. See also that the guide is clean and lubricated. A new valve must be similarly faced to its seat or it will not be compression-tight.

If there is not any very great improvement in the compression just at first, the motorist must not be disappointed. It takes some little time before a newly-ground valve becomes perfectly gas-tight.

After successive grindings, it is sometimes found that the valves sit so far down on their seatings that the stems make firm contact with the plungers which left them, and thus prevent the valves from properly closing. To remedy this, sufficient should be ground off the end of the valve stem to prevent it coming into contact with the top of the plunger when the latter is at the lowest point. It should be borne in mind that, owing to the expansion caused by the heat, the valve stem may clear the plunger when cold, but touch it when the engine is working. Therefore, this adjustment should be made when the engine is hot, and, where adjustable plungers are used, it is best to make the adjustment in the plunger rather than to grind the end of the valve stem. When the valve is seated, the plunger at the bottom of its stroke and the engine hot, there should just be daylight between the top of the plunger and the bottom of the valve stem. In multi-cylindered engines it is important that the distance between plunger head and the bottom of valve stem should be the same for all cylinders both for exhaust and inlet valves. In cases where the stem is too short and the exhaust valve does not open enough, thus causing back pressure, a new valve should be fitted.

Should the cotter holding the spring of the valve work out of place, the spring will cease to act, and the valve will become inoperative. The piston will then cease to draw in its charge of gas. If the spring is too weak, the valve will return to its seating sluggishly, thus allowing burnt gases to be sucked back on the next suction stroke, and affecting the power of the engine. A new spring is the remedy. Overheating or long usage will affect the temper of the spring and weaken it. This trouble may be tested for by placing the end of a turnscrew between the upper coils of the spring and exerting a downward pull on same. If the motor picks up speed, it may be taken as an indication that the spring has lost its correct tension.

Too great a clearance between the valve stem and its plunger will cause insufficient lift and account for sluggish running and overheating. Remedy, place a thin cap on the top of the plunger rod, that is, if it is not already provided with a screw cap to take up the wear. A worm cam or plunger roller will also effect the opening of the valve; a 1-16 inch reduction will be sufficient to appreciably alter the time of opening and its duration; the effect will be to produce overheating and sluggish running. Some types of cams are more prone to rapid wear than others; the ideal one is that which has its profile so shaped as to lift the valve without excessive side thrust on the tappet head or roller, and so "backed off" as to insure a prompt closing without undue clatter or shock to the valve head. The length of the cam's lifting surface should be sufficient to insure the valve being held fully open until the completion of the exhaust stroke. In modern engines the wear on the cam and roller is very slight indeed.

A broken exhaust or inlet valve will instantly lead to a total loss of compression in the cylinder. The engine should be stopped at once, or the broken parts may get jammed in the combustion chamber and do damage. The bits should be carefully removed. If difficulty is experienced a bent wire is useful. Small particles can be got up with the aid of some sticky material, such as pitch or cobbler's wax, smeared on to the end of the wire.

In the case of the automatically operated inlet valve, where the suction in the cylinder opens the valve against the pressure of a spring—a method now practically discarded except in the case of some motorcycle engines—no very definite rule can be laid down as to the exact resistance of the spring suited for every form of valve. Generally speaking, the practice is to use a spring which errs on the heavy or strong side. Such a spring will prove a trifle sluggish on starting the engine, but will function correctly when the speed has been accelerated. Compared with a slack or light inlet spring, the mixture volume will remain more constant, as there will be no puffing back at the carbureter.

In multi-cylinder engines, if the springs of the automatically-operated inlet valves are not of equal tension the power of the engine will be affected. To test the tension, remove the valves, and taking one in each hand, press the spindles against each other. If the valves open simultaneously the springs have an equal tension. A slight difference is not of great consequence.

The springs may have lost their elasticity, due to excessive heat. They should then be tested against a new spring.

As to the best time for opening and closing the valves, practice varies, and the reader is referred to the table given in the article on "Timing" in letter T. In this matter so much depends on design—for example, valve area, placing of valves, and nature of the valve pockets, together with the cubical capacity of the cylinder, compression degree, and intended normal engine speed—that it is only possible to generalize.

WATER CIRCULATION.

Symptoms: Overheating.—Sluggish running.—Steam.

Causes: Pump.—Defective.—Broken.—Spindle locked or friction-wheel not working or slipping.—Chain broken or detached (in chain drive).—Worn washers, valves, or bearings.—Grease in pump.—Frozen pump.

Pipes: Choked.—Broken.—Leaking.—Air-bound or Steam-bound.

Radiator: Grease or other deposit.—Mud in gills.—Improper proportion between the amount of water and the cooling surface of radiator.

Fan: Belt slipping or breaking.

Water Jacket: Leaks.—Deposit.

Any failure in the water circulation, unless detected at once, will cause overheating, the results of which may prove very serious. For this reason a careful watch should be kept on the water pressure gauge; but if that useful index is not fitted, the engine and pipes should be felt by hand. Should the car begin to run sluggishly the test tap should be opened where such is fitted, or some means found of discovering if the usual volume of water is circulating. Steam rising from the vent-hole in tank or radiators is a sign that the temperature is getting dangerously high. That the circulation is going on properly can be generally seen by opening the filling cap on the top of the radiator. In case of failure, the following are the points to look to for defects:

(a) **The Pump**—Should the pump not be functioning properly, it will be comparatively cool to the touch as compared with the water jacket and pipes. If the drive is by friction-wheel, see that the wheel is not slipping. If it is, slightly tension the spring so as to make the contact just sufficient to fully overcome the vibration of the road. Over-tightening only brings a severe strain on the pump bearings, and may render the spindle useless, or destroy the ball races if such be fitted. If the leather on the wheel is greasy, carefully clean it and the part of the flywheel against which it bears with gasolene or kerosene. See that the spindle has not seized in its bearings for lack of lubrication. The friction-driven pump is now seldom fitted.

If a chain drive, the chain might break or come off, which is generally due to undue slackness. It should be adjusted until there is a just perceptible sag. If the pump is gear-driven, there is not so much danger of trouble, though the key or the coupling by which it is driven may shear or come adrift.

The drive being right, the next point to make sure of is that the internal economy of the pump is in order.

Centrifugal and cog-wheel pumps are the two types most in use for motor cars. The first requires a higher speed than that which is necessary for the latter. As the centrifugal pump is merely a fan-wheel revolving in an inclosed chamber, there is practically nothing to get out of order, and from this point of view it is better than the other, but its high speed is trying to the bearings, and it is these that cause trouble with this type of pump. Dirt may possibly get in, but a thorough washing out will remedy this. If grit is allowed to remain in the pump it may wear the bearings and affect its efficiency. The application of a hose is generally effective. The bearings are usually of the plain type, and if in proper order the friction set up in them is very slight. They should be kept well greased with a grease pump, and if any heat is noticeable the car should not be run till the cause is ascertained.

For the efficient working of a cog-wheel pump it is necessary that there should be but a slight suspicion of side play —that is, between the flanges of the pump casing and the side of the cog-wheels. A curious species of trouble in some types of this class of pump is set up by the shearing of the pins or keys fixing the wheels on the spindles. In modern practice the drive between the engine shaft and the pump spindle is so arranged as to be in sight and easily removable, so that there is no difficulty in seeing if the pump is working.

A slight leakage of water is not of much consequence. If, however, the leak is bad, see that the grease cup is thoroughly full, and screw the top partially home. Also see that the packing gland nut is tight. If the packing wears, it will have to be replaced. Tow, greased with tallow, makes the best packing. It is well, when testing the pump, to run the engine at its normal speed, as the velocity of the water from the pump to the jacket varies with the speed of the engine.

(b) Danger from Frost—If the pump freezes and the engine is started it will probably result in the shearing of the key, and also damage to the key way. A temporary roadside repair may be effected, but it is really a job for a skilled mechanic, as it is essential that the key should be a perfect fit in the key way and boss.

When the temperature is below freezing point there is the danger of the water freezing in the circulation system, which often results in cracked water jackets or burst pipes.

Many motorists have had their water jackets, pipes, etc., ruined from this cause, and incurred great expense thereby. The only safe remedy is to have the garage heated, by means of hot air, hot water, etc., as in the ordinary conservatory. Such an installment, however, may entail a great deal of expense, but the difficulty can be got over in a much simpler and cheaper manner by using one of the stoves which burn a special fuel. In one such stove used in Europe, the fuel is in the form of small cylinders. Two or three of these are placed in a fire for a few minutes; they are then put into the lower portion of the stove, and other cylinders piled on top.

A single charge will last an entire night, and the heat can be controlled to a nicety by varying the air inlet. The fuel only smolders, and will not ignite gasolene. In fact, gasolene, it is said, can be poured over one of these stoves without any ill result. For this reason the insurance companies permit their use. Apart altogether from the danger of freezing, the use of these stoves, by making the atmosphere comparatively dry and equable in the motor house, is a saving to the carriage work, upholstery, tires, etc. This applies of course to private garages, public garages being usually properly heated.

When touring, however, or away from home, a heated garage is sometimes hard to find, in fact it is seldom available. Under such circumstances the car should be run into the house provided for it so that the front portion will occupy the farthest corner from the entrance, and the water should be drawn out of the water system as far as possible. In letting the water off, the cap of the filling pipe should be unscrewed. The pipe leading from the water jacket should be opened, and also the cock of the pipe leading from the radiator to tank. If there is a cock or plug to the radiator, this should also be left open to insure the last drop of water draining away, and also the cocks or plugs often used to drain the water jackets. It is not sufficient to open a cock somewhere in the circulating system without making quite sure that the cock in question is at the lowest point, for very often cocks are fitted merely for testing the circulation, or washing out purposes, and are not in the right position to entirely drain the system. It is sometimes impossible to completely drain the pump, so in frosty weather it is well, before starting, to gently heat the metal casing by means of hot cloths, etc., in order to get rid of any ice that might interfere with its proper working, and which sometimes results in the driving spindle shearing off. Should the carbureter be water-jacketed, the freezing of the water will, in most cases, burst the jacket.

In very many cases, however, it is impossible to entirely empty the water system, and even a very trifling amount of liquid at the bottom of the water jacket, or in the pump, may cause serious damage. We have known of a case where a sandy deposit in the bottom of the jacket has retained sufficient moisture to burst it. It is possible also that the taps may be choked. For this reason we should recommend the motorist to pile all available rugs over the engine bonnet. This will prevent freezing unless the frost is very severe. In the latter case the only really safe method is to use some preparation calculated to entirely prevent freezing.

By adding chemicals to the water the freezing point is lowered, and if the water were always kept at a very low temperature the number of substances that could be added without injury to the pipes, etc., would be fairly large, but the number is limited by the fact that during the working of the engine the temperature is raised to nearly boiling point. This heat is quite sufficient to decompose many of the added substances, setting free agents which would attack and eat away the metal of the pipes and tanks. The safest, but most expensive, substance to add to the circulating water is glycerine; but it must be kept in mind that fresh glycerine must be occasionally added to make up for the losses which occur through the glycerine being carried off with the steam. Calcium chloride can also be used for the same purpose; it is cheap, easily obtainable, and it is stated by those who have used it to be innocuous. See Anti-freezing Solutions.

(c) **The Pipes and Connections**—An air-lock in the pipes is exceedingly difficult to diagnose, in that it frequently only partially interferes with the water circulation. In the majority of modern cars there is little danger of an air-lock being formed, but with the older forms of vehicle with the low down radiator and a separate water tank it may occur. If an air-lock is suspected it is best to open every available water or air orifice and thoroughly drain out all water and fill up again with these openings only partially closed so as to allow the air to escape as the water comes in.

Leaking or broken pipes can easily be mended temporarily by connecting the fractured parts with a piece of rubber tubing, wired into position, and for this purpose suitable tubing should always be carried. Although a fairly good job can be made by means of wiring, it is much better to use a band, such as supplied by many dealers. A patented clip is made of a single strip of copper, broadened at one end, which is provided with a slot, through which the strip is passed and wrapped a second time round the rubber pipe, the usual screw and flynut drawing the ends tight and insuring a perfectly concentric grip of the pipe. The head of the screw is square and bears against a flat shoulder on the copper strip, so that when once pushed in, the screw will not turn round; thus there is no need to hold the end of the screw with spanner, pliers or screwdriver when turning the flynut home.

Where a long length of flexible pipe is necessary, the use of wire-armored rubber hose instead of metal pipes will minimize the risk of breakage or leakage. This hose accommodates itself to vibration, and causes but little strain on the unions.

It is advisable also to occasionally renew such hose connections, especially if there has been any prolonged overheating of the pipes and radiator, as such will rapidly cause the rubber to disintegrate or parboil, the result being that particles will find their way into the passages and possibly cause failure at the pump later. For the same reason the motorist should use only the best quality armored or unarmored steam hose, as he prefers.

In using armored hose, trouble is sometimes experienced with the ends of the wire coil which forms the armor around the tube becoming loose and straggling away from the tube. The best way to overcome this is to bend the last turn of the coil upon itself and fix with a blob of soft tinsmith's solder.

A leaking faced joint can be temporarily repaired by smearing the two faces with boiled linseed oil and a coating of white lead before putting together; but a "faced" joint should be treated as such, and re-faced when repair is called for. (See Joints.)

Should a pipe break about the union which secures it to the cylinder, a temporary repair may, in many cases, be effected by binding thin rubber tubing, such as is used for bicycle tubes, round the union and nut and wiring it on to the broken end of the pipe. Even sheet rubber can be made to do service, and a strong rubber band is an excellent thing for securing it to the union socket. Of course the weight will have to be taken off this joint by means of wire supports or otherwise.

(d) **The Radiator**—Very often the radiator is at fault, being insufficient to cool the water. Deposit may get into the radiator from the pump or otherwise, but if water is used which is free from lime and foreign matter of that kind rust may result, but very little scale. If, on the other hand, the water is limy or chalky there is not much rust, but a lot of scale. Either can be got rid of by a thorough swilling through with a strong solution of soda. The solution should be left in for an hour or two and then run off, and if much deposit comes away another dose should be given. Rain water is best, provided it is put through a strainer. One authority says that he has never found that rust mattered much. In fact, he has come to the conclusion that the best thing to do is to let rust form and not to change the water any time unless it gets thick.

The motorist should be careful when buying his car to see that adequate means for dealing with so important a matter as flushing or cleaning exist. A radiator without such provision is much akin to a boiler without a manhole or mud doors. Needless to say, such would not pass an inspector. It is to be recommended that the radiator be systematically flushed periodically—say in the case of a much-used car every month or so—but as much depends on local circumstances, for example, nature of the water, type of radiator, and the disposition of the same on the car, only an approximate rule can be given. A honeycomb radiator requires careful treatment as regards cleaning. With some of them it would seem impossible to internally cleanse them, and when they become so furred as to seriously fail in their work it will be the cheaper, and often the only method, to get a competent mechanic to deal with the job.

It is necessary to see that the radiator is not choked on the outside with dust or mud.

Leakages may usually be stopped by the use of a soldering bit with resin as a flux. A useful combined solder and resin is sold in sticks, and one of these should be carried on a car. Any tinsmith is competent to staunch a leak or effect repair to the common form of radiator, but the honeycomb type requires most careful treatment, lest in tightening one tube a whole series may be made leaky. It is essentially special work, and should be referred to some maker of motor fittings. For temporary repairs to leaking pipes, or tubular radiators, a useful remedy will be found in mixing genuine white lead with a dusting of litharge to the consistency of thin putty and smearing the same over the point of leakage, afterwards "serving" it with a bandage of waxed light thread, or failing the latter, a narrow tape previously steeped in boiled oil. A couple of strands of light copper wire then applied will prevent the bandage slackening back.

One of the special plugs used for stopping leaks should be kept by every motorist whose car is fitted with a honeycomb radiator. A very simple contrivance consists of two squares of thin plate aluminum with sheet rubber attached to one side. On the side carrying the sheet rubber there is a little lug, and one end of a spiral spring is hooked on to one of the plugs. With the plug is supplied a jointed wire about 6 inches long. This is passed through the defective tube in the radiator, and the other end of the spring is looped on to a hook in the wire. The spring is then pulled through the tube by the aid of the wire until the end protrudes at the far side of the radiator when the second plug is hooked on to the other side of the spring. The tension of the spring keeps the rubber faces tight up against the faulty section of the radiator, and so effectively stops the leak. The whole arrangement is simple and can be fitted by anybody.

To minimize the risk of pipes and radiators getting choked with a deposit of foreign matter, some owners use a wide-spouted water can, with a piece of Turkish bath towel tightly folded and jammed into the base of the spout. This forms an effective filter.

(e) **The Fan**—If the belt slips the fan will not revolve fast enough to keep the water adequately cool. Clean periodically, dress with castor oil, and keep well adjusted.

(f) **The Water Jacket**—A leakage or crack in the water jacket is not uncommon, and will affect its efficiency. The best method of dealing with same is described under "Cylinders" in Repairs and Adjustments.

The water jackets should be examined periodically to see if any furring-up or corrosion has taken place. They might be well hosed out with a hose pipe, and a powerful stream of water sent through until it comes out quite clear and free from rust deposit. This should be sent through from all the inlets and in the opposite direction through the outlets, the position of the cylinders being constantly altered so as to insure the water thoroughly swilling out all round the valve ports and corners. In extreme cases of furring, it may be advisable to boil the cylinder for some time in strong soda-water. A gentle tapping on the outside of the cylinder with a hammer, but not so heavily as to cause any damage, will then often result in the "sediment" on the walls coming away. In some cylinders the water jackets can be got at from the top by taking off the cover completely, and in this case, a steel instrument, or a rod with a hardened end, may be used to detach any incrustation which may have formed round the walls. Care must be taken to insure that all the small pieces and loose grit and sediment are thoroughly swilled out and cleaned away, otherwise they may cause obstruction in the pump and circulating system, even to the extent of actually damaging the pump.

WHEELS (ROAD).

Symptoms: Wheels out of alignment.—Looseness or creak in spokes.—Faulty steering.—Tires scored transversely.

Causes: Bent car axle, stub axle on which wheels revolve, steering link, or steering arms.—Spoke broken, cracked, shrunk, decayed, loose in hub.—Bearings worn or loose.—Hub shaky.—Springs moving fore and aft on axle.—Axle moving endways on springs.

If the wheels incline outward at the top it will generally be found that the axle is bent. This trouble is dealt with under "Bent Axle" in Repairs and Adjustments. If they incline inward at the top the bearings want adjusting. Failure in the wheels themselves is a much more serious matter, for they are apt to collapse at a corner or from a side-slip without the slightest warning. For this reason they should be subjected to frequent and close inspection. Incipient cracks and splits can generally be seen, but internal weaknesses, shaky hubs, loose spokes, and defective or shrunken wood are very difficult to locate. The wheels should be jacked up and pulled and pushed violently backward and forward. If there is lateral movement between the rims and hubs, or anything of the nature of a creak, it may be taken for granted that something is wrong. The tightness of the spokes can be tested by tapping them with a spanner or such like. The different note between those that are sound and those that are not will be at once apparent. The best plan under such circumstances is to take the wheels at once to a first-class coachbuilder who is accustomed to motor car work and have them examined. If there is any doubt whatever as to the repair proving a good job it is far better to order new wheels. It is simply suicidal to continue using faulty ones.

Trouble with wire wheels is very easy to locate. A broken or loose spoke is the most usual failing, and the immediate effect is to make the rim untrue. The wheel can easily be trued by fitting a new spoke, or re-tensioning the loose ones. It is very rare for a faulty wire wheel to collapse, as a wooden wheel will, without definite warning.

Needless to say, the bearings should frequently be examined for wear. (See Bearings.)

It is essential that the wheels should be in correct alignment, or the steering will prove defective, and the tires wear ment. Sometimes, especially where chains are used, the back wheels will be put out of alignment with the front by uneven adjustment of the chains through the medium of the radius rods. (See "Chains" in Repairs and Adjustments.) This will cause the car to run sideways and put considerable strain on the springs and steering mechanism. It can be remedied by readjustment of the radius rods, or, as they are sometimes termed, chain stays. In the case of the Daimler and some other chain cars there is an eccentric adjustment. It is best to ascertain that the back axle is square with the frame by careful measurement to the front of the chassis on each side, and determining that the distances are the same.

Another difficulty which sometimes arises, and which puts the back and front pairs of wheels out of alignment with each other, is the slipping sideways of the springs on the axle or axles. This cannot happen in those cases, found in the best practice, where spring plates are forged solid with the axle and the spring straps pass through holes in the plates. But sometimes the spring plates are strapped to the square axle by means of the same straps which hold the springs. In such cases on the nuts becoming loose or the straps stretched, the springs may move bodily with the straps and plates along the axle, thus putting the wheels out of alignment.

The distance they have moved is generally indicated by the rubbing away of the paint and varnish. The nuts should be slightly untightened, and the spring, plate, and straps driven back into position by means of a hard wood block and a heavy hammer. The nuts should then be carefully tightened up and locked. If the trouble continues to occur, a simple remedy is to drill a couple of quarter-inch holes in the top of the solid axle adjacent to the sides of the plates—one on each side—and drive in a tapered steel pin which will prevent the end movement of the spring plate on the axle.

Sometimes trouble arises due to the spring moving fore-and-aft on the axle or spring plate. This is also due to the straps stretching, or the nuts slacking back, or to a violent blow, as in an end-on collision.

In such cases the nuts should be slacked back and the axle driven, by means of a hard wood block and a heavy hammer, in the required direction, and then tightened up again. During the operation the car should be on a level place and unladen. The distances from the front dumb-iron or the front spring hanger to the axle should be measured on each side and should coincide.

A bent axle (see "Bent Axle" in Repairs and Adjustments) may put them out of alignment, but it is usually due to the steering arms or steering link connecting them getting bent (see "Steering Gear" in Repairs and Adjustments). Very often by standing some distance behind or before the car, preferably when it is in motion, the defect can be distinguished by the eye. The best test, however, is to get a straight edge and check the alignment of the back and front wheels as regards each other. This can best be done with the tires deflated so that the straight edge rests against the rim of the wheel and always parallel with the ground. The next point to make sure of is whether the two front wheels are absolutely parallel to each other. With a tape measure check the distance from rim edge to rim edge of the front portion of the two wheels, and then to the back portions. This test will only give true results if carried out when the steering wheels are set for the car to run straight forward. If there is any difference it will prove that the wheels are not parallel. Adjusting the steering link may make matters right, but the trouble may be due to a bent steering arm (see "Steering Troubles" in Repairs and Adjustments), and take some little skill to detect. As already mentioned, a bent axle will affect the alignment. The stub axles, about which the wheels revolve, may also be the cause of the trouble, but it must be borne in mind that in many cars the stub axles are deflected downward to enable dished wheels to be used, so that the distance between the tops of the rims and the bottoms of the rims will not correspond. Should the stub axles be further bent upward or downward, however, the variation in angle of the two wheels will easily be seen. If at all possible, the work should be placed in the hands of an expert.

Repairs, Roadside—See Miscellaneous Roadside Repairs.

Replacing Magnetos Correctly—See under Ignition.

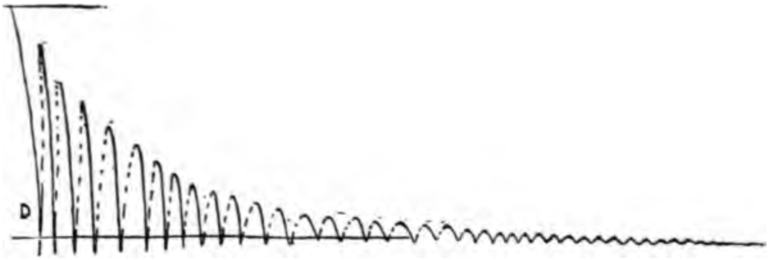
Replacing Tires—See Wheels and Tires.

Reservoir—See Tanks.

Resilience—The act of springing back; elasticity, a rebounding after the removal or cessation of a deforming force. Also the mechanical work done by a body in springing back.

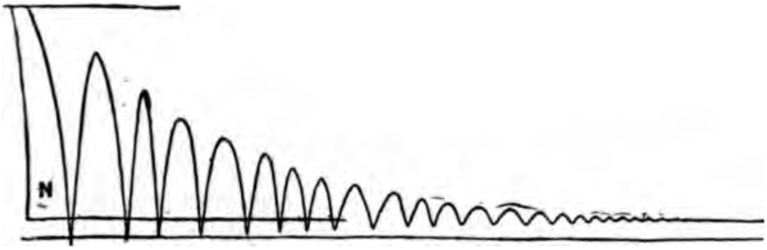
Resiliometer—An instrument for testing the resilience of tires; invented by Mr. C. E. Duryea of Reading, Pennsylvania.

Herewith are shown two Duryea resiliometer cards, explained by the inventor. "the original auto man," as follows:



"In 'D' the total distance between the lines represents the distance the tire was allowed to fall. The points below the line indicate the flattening of the tire under the effect of the fall. The height of the first point above the line is the measure of the resiliency of the tire. Of course the relation of the second point to the first should be the same measure. The energy of the fall is largely expended by the bending of the tire walls. If the tire has stiff walls, the number of rebounds will be less than if it has flexible walls. Therefore the number of points is a measure of the stiffness of the tire walls. The ability to rebound from a flat surface is a fair measure of the speed qualities of the tire.

"But tires are largely used because of the roughnesses of the roads and the small obstacles therein. 'N' represents the movements of a tire dropped onto an obstacle like a round bar. It was evidently a stiff tire as compared with 'D,' for it died out in 22 bounds whereas the other made 38. The bar so fully carried the load that the tire flattened on the ground slightly twice and touched the ground once; the remaining bounds being from the obstacle. This indicates great strain on the fabric to carry the load on such small area and small absorbing ability with consequent rough riding.



"The irregular spacing of the bounds is due to the irregular hand movement of the cards over which the bounding wheel caused a pencil to move. Vertical movement only being of importance, the lateral irregularity made no difference."

Resin—A dark brown, transparent gum obtained especially from the pine tree and hardened by evaporation; used as a flux for soldering; sometimes used in leather-faced clutches to make them grip, but it is injurious to the leather. See Soldering.

Resistance—The opposition of an electrical conductor to the passage of an electric current. The unit of resistance is 1 ohm, and this is defined as the resistance offered to an unvarying electric current by a column of mercury weighing 14.4521 grammes, of constant cross section, and 106.3 centimeters in length.

Resistance Coil—A coil of insulated wire connected in series in an electric circuit, in order to moderate the amount of current flowing through the circuit.

Resistance coils are used on electric cars in order to regulate the flow of current through the motor armature when starting and for varying speed.

Resistance, Electric—See Resistance above.

Resistance, Engine—See under Compression.

Restivity—In electricity, (a) the specific resistance of a substance with reference to the resistance of a cube of unit volume; (b) specific resistance or the inverse of specific conductivity; (c) a quantity in the c.g.s. electromagnetic system represented in square centimeters per second.

Restricted Exhaust—See under Pounding and Knocking.

Restricted Gas Supply—See under Missing Explosions.

Retainer—A ball race or roller cage in ball and roller bearings respectively.

Retardation—The act of hindering the free progress or velocity of a body and ultimately, therefore, stopping it. It arises from the opposition of the medium in which the body moves, or from the friction of the surface on which it moves, or from the action of gravity. The opposite of Acceleration, which see.

Retarding With the Engine—See Engine, Retarding with.

Retiming, Notes on—See Valve Setting and Ignition Timing.

Return Elbow—A fitting or coupling shaped like the letter U, used for connecting the ends of two pipes that lie parallel to each other.

Returning to Slow Speed Gear—See under Driving.

Revarnishing Car Bodies—See under Carriage Work.

Reversal of Engine Rotation—Motor-car engines will be found occasionally to start, and rotate for some time anti-clockwise; that is, in the opposite direction to the normal. If the starting handle happens to be in engagement at the time of reversal it will not disengage itself but will rotate and may deal heavy blows to anything that may be within its circle of action. An engine fitted with a voluminous muffler and the crankshaft of which from some cause requires a large number of turns (by the starting handle) before the occurrence of the initial explosion, and one whose exhaust valves are opened during the end of the explosion stroke (as is usual), are occasionally prone to this trouble, especially when the mixture has been made very rich by flooding the carbureter. There are various causes of reversal, and the most common is as follows:

In the first place, the muffler has become filled with explosive mixture. This very commonly happens, either because the engine continued to run by its own inertia after the electric current was cut off (with a view to stopping it) after it was last used, or because a quantity of unburned mixture had been made and put in the muffler by the mere fact of turning the engine over several times after the carbureter has been flooded in the usual way during the attempt to start it by hand. In the second place, it is to be noted that an explosive mixture is present in all the cylinders under these conditions. If, now, one of the pistons is carried up against the compression but not past it, and the starting handle then released, the pressure of the compression will force the engine backward for a little more than half a revolution. This action is liable to start the reversal in question.

Consider any one cylinder, and suppose the spark to be timed exactly on the "dead center," which is a point exactly between the compression and the explosion stroke. Had ignition taken place just after the dead center within the cylinder we are considering, the cycle of operations in that cylinder would be as follows: Spark and expansion, exhaust, inlet, compression. But if the rotation is reversed the cycle of operations will be reversed; that is, compression, spark and expansion, exhaust into carbureter, inlet from muffler. It will be seen that a short suction or inlet stroke is taken out of the stock of explosive mixture in the muffler. Next this charge is compressed during the inverted stroke, which ought to have been an explosion stroke in the normal case, the valves being closed. Next, this compressed charge is ignited and expanded during what ought to have been the compression stroke, the valves being still closed. Next, the inlet valve opens and permits the products of combustion to be exhausted into the carbureter; and, lastly, the suction of explosive mixture from the muffler is once more repeated.

The difficult thing to understand is how the small stock of vapor in the muffler can keep the engine running backward for as long a time as occasionally happens. In explanation of this it is suggested that as the exhaust stroke into the carbureter is rapidly followed by an inlet or suction stroke, which occurs before the passage of the carbureter is closed; there is considerable back pressure in the carbureter and its pipes owing to the exhaust which has been poured into it, and this pressure will force a certain quantity of gasolene vapor back into the cylinder and supplement the gasolene vapor which is taken from the muffler for the next explosion.

Reverse, Driving on the—See under Driving.

Reverse—A short term used to indicate the reverse gear or the action of reversing.

Reverse Gear—See Reversing Gear.

Reverse Motion—See under Change Speed Gear.

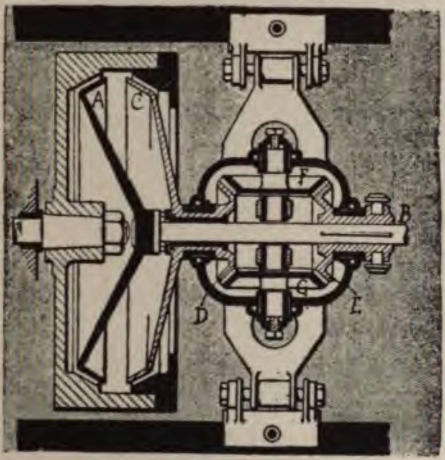
Reversible Steering—An antiquated form of simple steering apparatus for automobiles resembling that of a bicycle and permitting the steering tiller or wheel to be reversed in the driver's hands by unexpected obstacles or stress, besides making great demands on the driver's strength. The best modern steering gear is so arranged as to be irreversible.

Reversing Engine—A steam engine with reversing gear.

Reversing Gear—A reversing gear on a steam engine, or a steam car, is an entirely different piece of mechanism from the reverse gear on an internal combustion engined car. See Change Speed Gear. It is a mechanism which alters the sequence of operation of the valves. Generally it is arranged to put one or other of two eccentrics into working connection with the valve stem of the sliding valve of a steam engine.

This is done by links, in which case it is known as the Stephenson link gear. In other cases, and in more modern practice in steam cars, it is worked by sliding the camshaft —which operates valves of the tappet type—longitudinally, so as to put other cams into operation which will cause the engine to turn in the opposite direction.

The illustration shows a form of reversing gear for automobiles recently patented by P. Daimler, Unterturkheim, Germany. In this transmission set a double clutch is used. The forward male member A is secured to a solid shaft B and on which shaft is what appears to be a differential, but is a gearing by which the two male portions of the cone are connected. The rear male portion C is on a sleeve loose on the driveshaft and carries a bevel gear D. The driveshaft also has keyed to it a bevel gear E and connecting these bevel gears is a pair of other bevels F and G. Should the forward clutch A be engaged then the drive is direct along the driveshaft B, but at this time because of the gearing, the rear clutch C would be revolving idly in the opposite direction. Engaging the rear clutch C the drive is through the bevel



Daimler's Reverse Gear

gears D, F, G and E to the driveshaft B and at which time this shaft with the forward male portion A of the clutch is revolved in the opposite direction.

Reversing Lever—See Levers.

Reversing Link—See Reversing Gear.

Reversing Shaft—See Shafts.

Reversing Steam Cars—Do not reverse a steam engine when under way, for the sake of its brake effect, except in danger, for the reasons that:

1. The engine sucks in at the exhaust and thereby gathers in dirt, soot and grit, and very hot flue gases.
2. It compresses—first, steam to a very high temperature, beyond that of carbonization of all ordinary lubricants; and, later, the hot exhaust gases to an even higher and more objectionable temperature, with danger of seizing.
3. These pressures come upon the slide-valve, and the escaping gases will corrode it.
4. The reversed engine, when driven wrong way, does a certain small amount of work in the very direction it is meant to check.

Reviving Run-down Batteries—See Battery.

Revolution—The motion of a body around a center in a course which brings it back to the point at which it began to move. This motion is independent of any rotation.

Revolution Indicator—An instrument for indicating the number of revolutions made by a shaft or other part of a machine in a stated period of time. Also called Operameter.

Rheometer—An instrument to measure the energy of an electric current; a galvanometer or electrometer.

Rheophore—The name given by Ampère to the connecting wire of a voltaic apparatus, as being the transmitter of the current, which the composition of the word implies.

Rheostat—An apparatus comprising mechanism for graduating the amount of current passing in a closed electric circuit. It generally consists of a series of resistance coils of varying length so arranged that they can be put into circuit consecutively, thus graduating the current passing in the wire from a minimum to a maximum value by means of stops.

A very good resistance or rheostat can be obtained by coupling up in the circuit one or more incandescent lamps, as described under Battery.

Another method, largely in vogue, of accomplishing the same end is to immerse two plates in a conducting fluid, such as mercury, and lower or raise them to alter the submerged surface, and thus the resistance in the circuit.

Rib—In machinery, an angle-plate cast between two other plates to brace and strengthen them; any long, narrow strip; a flange, gill or fin cast on a cylinder for purposes of cooling, etc. In shipbuilding, a long strip of timber or iron following the curvature of the vessel, to hold its sides in position and impart stability to the skeleton.

Ribbon—A thin, narrow strip of metal, as a spiral spring, a thin steel belt used as a brake on a drum, etc.

Ribbon-brake—A friction brake having a band which nearly encircles the wheel or drum whose motion is to be checked.

Ride—To be supported in motion, as wheels on an axle or gear on a shaft. To climb up on or rise over its proper place, as a cogwheel when its teeth do not engage fairly.

Riffler—A kind of file with a somewhat curved extremity, suitable for working in small depressions.

Right-angled Cranks—See Steam Car.

Right-hand Screw—See Screws.

Rigidity of Frame—See under Frame.

Rim—The outside metal edge of a wheel corresponding to the tire of an ordinary wooden vehicle wheel. It is usually shaped with in-turned edges, so as to hold the beaded edges of the casing of a pneumatic tire.

Detachable Rims—Many forms of rims have been used which are detachable so that the inflated tire can be taken completely off the wheel with its rim, and a spare rim with an inflated tire attached quickly. There are a considerable number of these detachable rims on the market and their number is constantly being added to. Many are of great practical utility. "Demountable" wheels for a similar purpose have also recently come into use and are very successful.

In some cases rims are made not only detachable, but also having detachable flanges which enable the tire to be removed quickly from the rim without the use of tire levers and other tools. A combination of the two systems is found in some types, and seems to be the most practical, as, in the event of two replacements having to be made, only one spare rim need be carried, and any other puncture which might occur could be easily manipulated by the quick removal of the casing by means of the detachable flange to the rim.

The steel rim of a wheel is by no means solely useful in supporting the tire. It has a large share of work to do by being put in tension whenever a side thrust comes upon a properly dished wheel. This gives great strength to the wheel as the steel is exceedingly strong in tension. If, however, the rim is not a tight fit (as it should be) on the wooden felloe, the strength of the wheel will suffer.

It is important that the correct section of tire should be ordered for any size of rim. In measuring round the rim certain markings and numbers on the steel will frequently be found which are intended to indicate the size of tire the rim maker intended to fit. These dimensions must not be mistaken for the dimensions of the rim itself.

Rim, Clincher—See Clinch, Clincher.

Rim-Clutch—Same as Contracting Clutch. See Clutch.

Rim, Detachable—See Rim; also Wheels and Tires.

Rim, Driving on the—See under Driving.

Rim, Efficiency at the—See under Efficiency.

Rimer—Same as Reamer, a workshop tool used for enlarging circular holes. It is generally slightly tapered and of circular form, having cutting teeth milled down its sides. Sometimes it is parallel, in which case it is used to finish a hole to a dead size. A rimer is useful to enlarge two holes which are intended to come opposite, but which, under some circumstances, do not quite coincide with each other. The rimer is then employed so as to make one larger parallel hole into which a bolt or other fitting will exactly fit through the two parts.

Ring Armature—An armature whose core is ring-shaped.

Ring Bolt—An iron bolt having a ring in one end of it.

Ring, Broken—See under Loss of Power.

Ring Lubrication—In some bearings lubrication is by means of a flat ring, which is used as a collar round the shaft. The center part of the bearing, both top and bottom, is cut away, so as to allow for the insertion of this ring, it being threaded over the shaft as this is put in position in the bearing. The ring is loose on the shaft, and hangs down into a little well in which the oil is held, and into which it dips. As the shaft rotates, the ring is moved round on it and draws the oil up from the well and around the shaft, thus keeping the bearings well supplied with oil.

Ring Lubricator—See under Lubricators.

Ring, Packing—See under Packing.

Rings—Split cast iron rings known as piston rings are fitted to pistons to form a gas-tight joint between the wall of the cylinder and the piston. See Internal Combustion Engine.

Rings are also used in bearings, in which case they run loose on the shaft to pick up lubricating oil from wells at the bottom of the bearings. See Ring Lubrication.

Packing rings are used around glands and between pipe flanges. See Packing.

Rings, Piston, Removal of—See Removal of the Rings, under Engines.

Ring Slots in Line—See under Loss of Power.

Rings Stuck, Piston—See under Loss of Power.

Risks of the Road—See Negotiating Road Risks, under Driving.

Rivet—A metal pin provided with a head. This is passed through opposite holes in two adjacent parts intended to be permanently fixed together, and the projecting end hammered over to form a head.

Riveting—An entire set of rivets and the work in which they are used.

Riveting, Double—Riveting in which two rows of rivets are used along a seam.

Riveting, Lap—Riveting in which the parts to be riveted overlap; distinguished from riveting where the parts jut against each other and are fastened by means of plates laid over the joint and riveted to each piece. The latter is called butt riveting.

Road—A public passage or highway, especially the portion traversed by vehicles.

Roadbooks—Guidebooks, often with maps, etc., covering particular localities in more or less detail, and giving information for automobilists as to the nature and grades of roads, character and convenience of hotels, garage or other accommodations for motor vehicles, local laws, ordinances and regulations concerning automobiles, etc. It is well to be supplied with reliable road books when touring, especially in strange territory, and the automobile clubs in very many places are doing notably good work in preparing such books.

Road Making—Under the head of Dust and elsewhere this subject is touched upon. The following is a pertinent memorandum by the British Roads Improvement Association upon the methods of making dustless roads:

"The seriousness of the dust difficulty is recognized by everybody, and it is the duty of every citizen to use his influence to abate the nuisance. The dust is due to (1) the grinding up of the materials of the road under traffic; (2) the presence between the hard stones of an unsuitable binding material; (3) the presence of horse droppings and other organic matter; and (4) the dust from the fields and roadside waste which is blown on to the road surface.

"It is the contention of the association that properly constructed roads made of suitable dustless materials will, in the end, prove of less cost to the taxpayers than any road made under present conditions. They will probably cost more in the first instance, but the increased life will more than counterbalance this, and the absence of dust and the reduction in tractive effort will result in great benefit to health and reduction in the cost of transport.

"The production of dust from cause (1) can only be prevented by thoroughly binding the materials on which the road surface is based; (2) by discontinuing the use of the prevalent binding materials and filling up the voids between the stones with some substance which will consolidate, and which cannot be sucked out by pneumatic tires; (3) by discouraging the use of animal traction; and (4) by a smooth surface which will not retain the dust or mud.

"One or other of the following methods may be found suitable in each locality. They are the systems which have been selected by the association for exhaustive tests on a length of main road. The materials will be tested under identically similar conditions, and the results obtained will be placed at the disposal of all local highway authorities and their officers.

"Armored Roads—A system of armoring the surface of existing roads has been introduced in many parts of Germany. It consists of rough setts or small blocks of granite, approximately 4½ in. cube, which are broken in a special machine and laid at random; that is to say, so that none of the joints run continuously. It is recommended that the setts should be held together by a cement grouting. The surface is very much like that of the present granite roads. It is known as Kelinpflaster.

"Quarrite—Many experiments have been made to find a suitable matrix for road construction, as it is generally admitted that tar does not fulfil all requirements. Quarrite is a patented material made from either granite or limestone with such a matrix for binding material.

"Tarred Limestone Macadam—A material somewhat similar to the above is being made from stone of a limestone nature. It is similarly bound with matrix, prepared from tar and consolidated by steam rolling.

"Slag—Several road engineers have introduced forms of tarred slag macadam in which slag is treated hot with tar, or a tar matrix which penetrates through all the pores of the material.

"Newstrand—A material that has been introduced, the basis of which is sand, specially treated in a patented machine, laid hot, and consolidated by rolling. The experimental pieces that have been laid show that it is very durable.

"Carbolithic Asphalt—A material that has been discovered in the course of experiments for quite a different object. An exceedingly hard substance which cannot under any circumstances wear to a polished surface, and therefore always affords an excellent foothold for both horse and pedestrian traffic. Heated in an ordinary pitch boiler and spread on the road and punned in with a hot iron. Like a French asphalt in appearance and costs about half as much as that material."

Many experiments are also being made on this side of the Atlantic with roadmaking materials and park boards and other public bodies are showing a disposition to lay considerable stretches of road that can be enjoyed by the automobilist with a minimum of dust and discomfort. Considerable success has been attained by the use of surface dressings of crude oil, etc.

Road Maps—See Road-books.

Road Metal—Crushed stone used in making and repairing macadam roads.

Road Resistance—The resistance which road surfaces offer to the progress of a vehicle varies largely with the nature of the road surface, and with the diameter of the wheel and the breadth of the tire.

The resistance with rubber and pneumatic tires is less than with iron tires. An eminent French engineer gives, as the mean result of his experiments, the following figures, which show the relative values of the different tires in tractive resistance. The pneumatic tire is calculated as a mean standard, giving 100.0:

Tractive resistance of pneumatic tires	100.0
Tractive resistance of solid rubber tires	129.8
Tractive resistance of iron tires	132.7

The tractive resistance increases with the speed of the vehicle, but the figures given above form a mean, and were obtained by testing at walking and trotting speeds.

Also the resistance decreases in proportion to the increase in the diameter of the wheel. This is explained by the fact that the smaller the wheel the further it will sink into depressions in the road surface, and more power is required to pull the wheels out of such depressions. The larger wheel bridges over such depressions, and, instead of sinking into, rolls over them.

Road, Rules of the—The rules of the road vary with locality and should be known and strictly observed by every driver of an automobile. The general rule in the United States is to keep to the right while in some other countries the custom is to drive to the left.

Roadside Repairs—See Miscellaneous Roadside Repairs.

Roads, Treacherous, Driving on—See under Driving.

Roadster—An automobile built for general use on the road, as distinguished from one for racing or other special purposes.

Road Wheel—The wheels of a motor car which bear its weight or have to take both weight and drive. See Wheels.

Rock Cork—A variety of asbestos resembling cork in its texture.

Rocker—A rocker is a lever pivoted at the center, having a slight oscillating motion. Rockers are used on the top of the cylinders in cases of those engines which have their inlet valves or their exhaust valves, or both, on the top of the cylinders. In such cases the rocker transmits the power from the tappet rod to the top of the valve stem.

Also a device to support the brush or brushes in a dynamo, electric motor or ignition contact maker.

Rocker Arm—Any one of the arms carried by a rocker shaft or rock-shaft.

Rocker Cam—A cam keyed to a rock-shaft. Also called a wiper.

Rocker Shaft Loose—See under Pounding and Knocking.

Rocker Shaft Worn or Loose—See under Loss of Power.

Rocking Motion—See under Motion.

Rock Leather—Same as Rock Cork, a cork-like variety of asbestos.

Rock Oil—Another name for petroleum.

Rock Shaft or Rocker Shaft—A shaft that rocks or oscillates, carrying arms or levers for reciprocating motion, etc. In ignition systems it is used to make momentary contact with the battery, etc., to secure a spark.

Rod—A length of metal maintaining the distance between two points; also used for transmitting motion, as the piston rod or the connecting rod in steam engines.

Rod, Connecting—The rod or bar which connects the piston with the crank of an internal combustion engine. In a steam engine the pitman which connects the crosshead with the crank. The ends of the connecting rod of automobile engines are known as the "big end" and "little end" respectively.

Rod, Distance—See Radius Rod. It is used to keep the parts of a driving-axle to which it is attached at a constant distance apart.

Rod, Piston—See under Piston.

Rod, Push—See Push-rod.

Rod, Radius—See Distance Rod and Radius Rod.

Rod, Tappet—A push-rod used for lifting the inlet and exhaust valves, etc., of a gasolene engine. It is a longitudinally reciprocating rod operated by a tappet, that is, an arm, collar, lever or cam, brought into contact with another movable part of the machine.

Rod, Valve—The rod or spindle to which a valve is attached and by which the valve is operated.

Roller—A cylindrical piece of metal used for roller bearings, tappet rods, clutch pedals, and such like, so as to substitute a rolling for a rubbing motion, thus reducing friction and wear. Sometimes used in contact makers.

Roller Bearings—Bearings in which rollers are used to reduce friction. See Bearings.

Roller, Cam—A small wheel at the base of a valve-stem, by which the valve-rod is lifted when the wheel is acted on by a cam.

Roller Chain—A driving-chain the blocks of which are in the form of rollers. See under Chain.

Roller Contact—See under Timing.

Rolling Friction—The resistance of uneven surfaces rolling on one another, like that of a wheel rolling on a road.

Rolling-mill—A plant in which molten steel is placed between heavy rolls and formed into sheets, bars, rods or wires.

Rope-Brake—A form of dynamometer.

Rope Driving Gear—A system of driving gear for motor cars in which ropes are employed to transmit power to the driving wheels. It obviates the use of differential gear by the sliding action of the ropes.

Rope, Wire—A number of wires of iron, steel, etc., twisted together to form a rope.

Rose—A perforated nozzle of a pipe, spout, etc., acting as a filter or strainer.

Rotary Contact Maker—See under Ignition.

Rotary Motion—See Motion.

Rotary Pump—See Pumps.

Rotary Valve—See Valves.

Rotation—The act of turning, as a wheel or solid body on its axis, as distinguished from a forward movement of the whole body.

Rotations, Couple Of—Two equal rotations in opposite directions about parallel axes.

Rotten Stone—A stone easily powdered, and obtained from the decomposition of limestone. Used for polishing and grinding, especially the softer metals.

Round Head Bolt—See Bolts and Nuts.

Round-headed Screw—See Screws.

r. p. m.—The usual abbreviation for "revolutions per minute."

Rubber—Pure indiarubber, or caoutchouc, is the sap of certain kinds of trees growing in South America and parts of Africa and Asia. It is obtained by making an incision in the bark of the tree from which the rubber flows. In its natural state it is white, but being partly cured by smoke the rubber turns the usual black color. Rubber is impermeable to water, and forms a very high insulator for electric current. It melts at about 150 degrees, and is soluble in ether and some spirits. It is very tenacious and elastic.

Vulcanized rubber is the usual form which is used for commercial purposes. By the process of vulcanization the rubber is rendered hard and elastic. To vulcanize rubber it is treated with a small percentage of sulphur and then subjected to strong heat and great pressure, the treatment during vulcanizing depending on the purpose for which the rubber is required.

Indiarubber, after being vulcanized, is affected both by air and light, but most adversely by light. For that reason rubber goods should always be stored in dark places and in a mild atmosphere.

The following article on rubber for automobiling purposes is from the pen of a motor-car engineer known in Europe and America:

The automobilist should know a few facts about this most important substance. It occurs in appliances which he uses:

1. In the insulation of wires.
2. In the foot-mat.
3. In the hose connections to the radiator.

4. In the tire pump pipe.
5. In the bag of the horn.
6. In the driver's waterproof apron, coat, etc.
7. In the tires.

In none of these is pure indiarubber used, nor would the enormous stretching quality, the stickiness, the rapid deterioration under air and light and in contact with certain metals, the great variation of properties which it exhibits with temperature changes, and, lastly, the very high cost, render it suitable.

The "rubber" of commerce ought to be called "vulcanized rubber compound," for it invariably contains more "compound" than rubber.

1. Electrical Wires—In this case the quantity of wire used is so small that the finest quality of covered wire should be purchased. Ignorance in this matter and kindred electrical trifles have led to more trouble with automobiles than any one single cause whatever, except tires.

By contrasting the cost of the cheapest possible covered wire with that of the best possible, it will be found that on a car costing say $1,500 a saving of two dollars at most might be made, and this saving will perhaps in the very first year of the car's life cost its user hours of worry, many dollars in damaged batteries, in the purchase of new coils under the idea that the coil is bad, and in repairs, generally effected by persons who are hopelessly ignorant of the elementary tests and devoid of the simple instruments, the training, or the spare material needed to make a sound electrical job.

The rubber-covered wires of the low-tension circuits should be of "600 megohm grade," or, better still, "2,500 megohm grade," and wires can be bought under the title, having any size of copper conductor required. The copper core should consist of a large number of fine copper wires.

It is highly important that they should be guaranteed by and bear the name of a good manufacturer. Besides being of the right grade electrically the rubber should stand the following mechanical test:

Test—Remove the braid and tape and pull out the copper wires; stretch the rubber tube till the length of the piece is doubled, fasten it to a board in the stretched condition for twenty-four hours, cut it free after that time and note that it should return to within 10 per cent of its original length in an hour. If it will not stretch without breaking, or will not return after being cut free, do not accept it, or at least do not allow it to be made a fixture in your car even if you are reduced to use it for temporary purposes.

High-tension wires are very much more thickly covered with rubber, but are not made in large enough quantities to correspond to any "grade." The stretching test may with advantage be applied to the rubber of these wires.

High-tension wires should not be taped over or braided near the ends, as the moisture-retaining quality of the tape and braid conduces to leakage.

On good insulated wires, such as suggested above, the mixture of substances called the "rubber compound" should contain at least 35 per cent pure rubber; the 65 per cent remaining consists of mineral powders, euphemistically called pigments, and sulphur.

2. Footmats.—The rubber used in these is of very much lower quality than that on wires, but here, again, the universal ignorance of the purchasing public prevents their getting the right thing. The amount of rubber in the compound may for economy be much less than in electrical coverings; resiliency is not required, nor is excessive flexibility, nor the power to withstand great vibration without cracking, nor electric insulation. If, however, the amount of pigment is increased to an enormous extent (and there is every inducement to do so, as long as rubber costs, say, $1.25 a pound and the pigment about one cent a pound), the mat becomes worthless—the cellules in the structure of the rubber are gorged with chalk, etc., so that the surface of the mat crumbles with the gentle chafing of the feet of the driver.

Being gorged to repletion, the indiarubber proper is (though the fact is invisible) already in a state of stretch which allows of no further stretch without tearing. A mat of this kind will, therefore, only stand being taken off the treadles of the car some dozen times, after which the splits extend and tear till the whole is in shreds; and yet mats must come off frequently to allow the mud and dirt brought in by the rider's shoes to be cleaned away from under the perforations which are invariably cut in mats.

There is an important difference between mats for motor cars and other rubber mats—viz., the necessity for light weight. A large trade in door-mats exists already, of course, and as the perforations make it difficult to estimate what quantity of rubber the mat will require, the purchase is usually effected at so much per pound of mat. There is here an obvious inducement to the maker to use for his pigment the heaviest mineral he can find. It did not take him long to find it in barytes, or "heavy spar," a mineral as heavy as cast-iron, and nearly as cheap as clay.

This may enable us to guess why it is that mats are often so fragile and of such prodigious weight.

Evidently the car mat may become more expensive per pound without being more expensive as a mat, provided it is made with much lighter compound which costs no more per unit of volume. With a little more expense it may be much stronger, more elastic to the feet, and less easily rent.

3. In the "hose connections" rubber is used, and there is again no call here for expensive highly-elastic rubber. The canvas of the hose withstands all the pressure and most of the bending, so that the rubber is merely called on to fill the interstices. A closed and complete rubber lining should be made to the tube to keep the internal water from rotting the canvas, and a complete external rubber sheath for the same reason. With hose, as with mats, old material, that is to say, rubber that has been manufactured and stocked away for over a year, should be scrupulously avoided, no matter how cheap. Owing to the small amount of rubber present in the compound and to its "gorged" condition a large surface of rubber is exposed in a thin layer to the air, light, and moisture; con-

sequently these low-grade rubber goods are highly perishable with time alone, whether they have been used or not. Old hose and ultra cheap hose are characterized by their brittleness when roughly handled and bent or kinked; they should be renewed. There is also some indication to the expert in their smell and in the way the rubber cuts with a knife. Once the glossy sheath of rubber which gives the glossy look to the rubber is broken the end is approaching. The evil day may be delayed by employing very stout "heavy delivery hose." This is so thick that it is difficult to kink it so that a crack starts less easily and the amount used is so small that the trifling extra cost is quite negligible compared to the trouble and labor of fitting a new tube when on the road.

5. The bag of the horn ought to be of very different quality; it should, on test, show an elongation and resiliency comparable with that for insulating wires.

It is most unfortunate that a black color has been allowed (probably because it shows off the plating of the horn proper) to become the standard thing. The black in the indiarubber bears no relation to its useful qualities: it is an index of nothing, neither of strength, resiliency, endurance, percentage of rubber in the compound, nor anything else, saving only that the manufacturer has added 1 or 2 per cent of lampblack to the mixture. This lampblack is always coming off on the driver's hands, gloves, and clothes as the rubber ball wears. The undyed and natural pale gray rubber is much superior from this point of view.

6. Waterproof—Rubber solution, vulcanized cold with sulphur chloride, is used to waterproof cloth, and is present on the clothes, as a rule, in rather small quantities.

If an oil-stain is removed from such clothes with gasolene the rubber will, in considerable measure, be removed also, and with it the water-proofness; the ring or spot where the gasolene was allowed to act will also have an ugly dark fringe where the extra rubber has collected.

In all cases, including tires of course, it is well known that lubricating oil, kerosene, gasolene, grease, and battery acid must be scrupulously kept away from any indiarubber that is wanted to last. It is not so well known that copper also acts as a "carrier" of oxygen to the rubber, and tends, where in contact with it, to perish it. The copper oxidizes in air, and yields its oxygen to the rubber. Nickel and iron are not so objectionable. For this reason the part of the horn which is in contact with the bag should be nickeled or tinned, and the part of the brass tube to the radiator to which the hose is connected should also be tinned.

Vulcanized rubber compound should not be exposed to a temperature of more than 180° F., though the limit at which rubber softens completely is the vulcanizing temperature of about 280° F.

Rubber Cement—A rubber solution used to repair rubber goods, etc. See Rubber Solution below; also Glue and Cement.

Rubber, Hard—Vulcanite or ebonite. See Rubber.

Rubber Joints—See under Circulation.

Rubber Packing—See under Packing.

Rubber, Quality of Tire—See Tires.

Rubber Solution—As its name implies, this is pure Para-rubber dissolved in spirit, carbon bisulphide, naphtha, etc. Rubber solution is used for applying patches to inner tubes and other repairs to rubber articles. This method, however, of repairing punctures in motor car tires is now practically superseded by the vulcanizing method. See Vulcanizer.

Rubber solution should be kept tightly sealed up, as the spirit in which it is dissolved rapidly evaporates, leaving only sticky rubber behind. It must also be remembered that it gives off an inflammable vapor, so that it is dangerous to keep it in any place where it may become exposed to a flame.

Stale rubber solution may be diluted with solvent naphtha, benzine or carbon bisulphide. Gasolene will also dilute it.

Rubber Tubes, Clamping—See under Circulation.

Rubber Tubing—This is formed of layers of rubber reinforced by canvas or other woven material and vulcanized together. It is used for pump connections for inflaters or tire pumps, for joining the pipes and units of a water circulation, and often for more thoroughly insulating electrical wires. It is also handy to put round rods operating brakes, etc., to prevent their rattling against adjacent parts of the vehicle.

Rudder—That which guides, governs or directs the course of anything. The flat frame by which a ship or boat is steered. The rudder is moved by a tiller or a wheel. The term is sometimes applied by analogy to the steering apparatus of a motor car.

Rudder-Head—The upper end of a rudder, into which the tiller is fitted.

Ruhmkorff Coil—In electricity, an induction-coil having an iron-wire core and a fine wire secondary coil of many turns for the production of powerful induced electromotive forces, usually excited from a battery or continuous current source through a suitable current-breaker. Named after H. D. Ruhmkorff who invented the earliest form.

Rules of the Road—See under Road.

Run—The aftermost part of a vessel's keel which becomes gradually narrower from the floor timbers to the sternpost.

A trip or excursion; distance covered on a trip, as a run of 200 miles.

Runaway—A runaway gasolene car, in the sense in which the public regard the matter, is almost an impossibility. When a car is left standing, the engine is always throttled down as far as possible, and is consequently giving a very small amount of power. The gear lever should be in the free notch under such circumstances, and the hand brake, whether interconnected with the clutch or not, left hard on. Unless there is an attendant left in charge of the car, the engine should be stopped during a call, lest some mischievous person move the gear lever.

The runaway that is the most likely to occur is in descending hills, if the brakes fail to work. See Driving.

Runabout—A term used to describe a small, light car; a voiturette.

A typical runabout has a special light two-passenger body fitted to a standard chassis and the rear portion of the body contains a folding seat as well as a roomy compartment for tools, baggage, etc. In some good models the driver's seat is almost equally distant from the front and rear axles, thus insuring the greatest comfort. This style of machine has become exceedingly popular for everyday and business use and promises to become more so.

Runner—In a system of pulleys, (a) a pulley attached to a shaft, as distinguished from accompanying idlers; (b) the moving block.

In molding, a channel conveying melted metal from the furnace to the cavity of the mold.

Running Board—One of the footboards running longitudinally between the wheels at the side of an automobile, by means of which entrance to the car is effected.

Running Brake—A foot brake. See Brakes.

Running Engines at Top Speed—See Causes of Overheating, under Engines.

Running Expenses—See Cost of Motoring.

Running Gear—A term used to denote the under carriage of a motor car, consisting of frame, wheels, axles, etc., but not including the motor or any of the working parts.

Running Gear, Bind of—See under Loss of Power.

Running Hot—The condition usually described as Overheating. See Overheating; Loss of Power; Engine, etc.

Russet Leather—Finished leather left unpolished and uncolored.

Rust—Oxid of iron. Oxidation is set up in metals by exposure to the atmosphere, especially in damp climates. Rust may occur in the water jackets of cylinders. It should be avoided by keeping all parts well greased, blackleaded, or painted, as the case may require. Nickelplating is used largely on motor vehicles to enhance their appearance and to protect from rust. The presence of rust usually denotes want of proper care and attention. For Rust in the Water Circulation System, see "Circulation" in Repairs and Adjustments.

Rust in the Rim—See under Wheels and Tires.

Rust Joint—A fast joint formed by uniting surfaces with a composition of iron filings and sal ammoniac, with sometimes a little sulphur, moistened with water. Oxidation rapidly sets in and the composition, which is commonly called rust, after a time becomes very hard and takes thorough hold of the parts connected by it.

Rust Spots—To remove rust spots from nickeled surfaces, grease the rusty part well, allowing the grease to remain for some hours, then rub with a rag dipped in ammonia. This treatment will do away with most rust spots, but if certain of these are obstinate, they should be carefully damped with a little diluted hydrochloric acid and wiped dry quickly. The surfaces so treated should then be washed with clean water and when dry, rubbed up with polishing powder.

Rutile—An ore of titanium, of a reddish-brown color, sometimes passing into red, found distributed in granite, gneiss, mica schists and granular limestones. Titanium is used for bearings where the highest degree of resistance to heat and friction are required.

Ruts—Narrow furrows on tracks worn in the ground by a wheel passing over it or by the continued passing of wheels. In driving an automobile ruts should be avoided as much as possible for the sake of the tires and the general strain on the running gear, especially in passing from them to the level road.

S

S—The chemical symbol for sulphur.

S.—As a abbreviation S. stands for various words, as for South, Society, etc. The lower-case form, s, is used as an abbreviation of "second," as in the c.g.s. or "centimeter-gram-second" system.

Sable Iron—A fine kind of Russian iron.

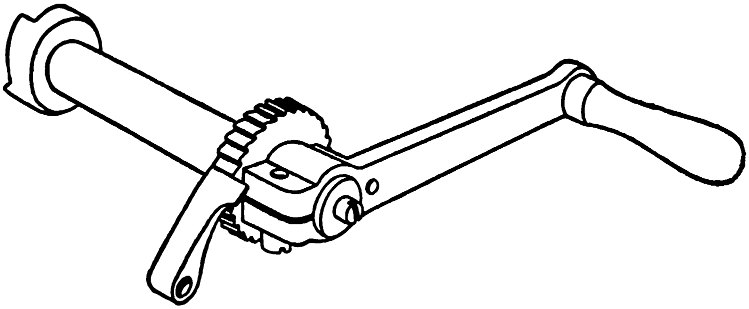
Saddle—The spring seat of a bicycle, tricycle, etc. In machinery a flange for support or attachment.

Saddle Joint—In sheet metal working, a joint formed by bending the edge of one sheet over the turned-up edge of another.

Saddle, Spring—The seat or part of a frame on which a spring rests.

Safe-edge—The smooth edge of a file.

Safety—A term used as an abbreviation of "safety bicycle" in the early days of low-wheeled bicycles with multiplying gear, to distinguish them from the old "ordinary" or high-wheeled bicycles.



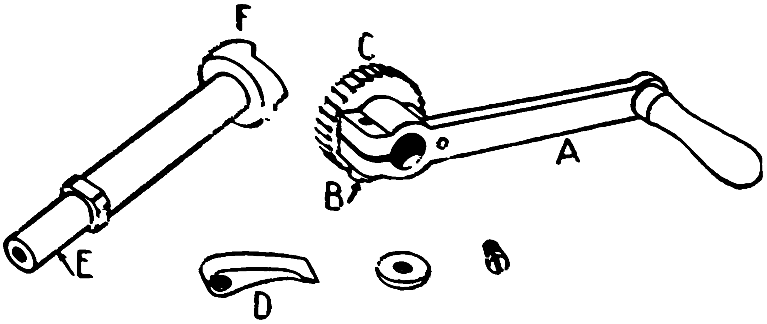
The Jones Safety Cranking Handle.

Safety Cranking Handle—The illustrations show the form and details of a safety cranking handle for motor cars and boats patented August 18, 1908, by W. S. Jones of Plainville, Conn.

This invention consists of a ratchet C fastened to the handle A to stop crank handle A from revolving backwards, and a friction joint at E to allow the engine and shaft to revolve backwards without the crank handle in case the engine back fires, as frequently happens.

In practice the screw B on the handle A is set sufficiently tight to hold the friction E from slipping under ordinary conditions; but should the engine run backwards, it would allow the shaft and clutch F to revolve with the engine without the handle, and without risk of breaking the ratchet C or pawl D.

In other respects this crank operates the same as those in general use, and is thrown off at F as usual when the engine starts right.



The attachment of the pawl to the frame of the car is usually by means of a stud on the frame. The frame of the car and journal for shaft comes between ratchet C and clutch F. The handle, ratchet and pawl are outside the frame and the clutch inside, as is usual in cars that crank in front.

The Jones invention, it is claimed, gives absolute safety to the person who cranks the motor, even if the engine backfires and runs backward, as frequently happens, many persons having been seriously hurt in this way.

Safety Fuse—A fuse consisting of a metal or wire piece of comparatively low resistance inserted in an electric circuit to guard against danger from excess of current. It melts or "blows out" and thus relieves the strain before damage is done.

Safety Plug—See under Plug.

Safety Valve—A contrivance for obviating or diminishing the risk of explosions in steam boilers. See Valves.

Sagging—A bending or sinking of any body, construction or frame work in consequence of the weight applied to it.

Sand—Any mass or collection of fine particles of stone, particularly of silicious stone, not strictly reduced to powder or dust. When consolidated by pressure or held together by some cement, it becomes sandstone.

Molding sand, used in foundry work, for making molds in which metals are cast, is a mixture of sand, clay and other materials.

Sand Blast—A process of cleaning, repolishing or decorating glass, metals, etc., by common hard sand driven against their surfaces by a blast of air or steam. The method is used for cleaning and resharpening files, etc.

Sand Blister—The result produced by sand working into the outer casing of a pneumatic tire, through cuts and gashes. The tires should be carefully watched to prevent such blisters.

Sand-boil—Same as Sand Blister.

Sand Jet—Same as Sand Blast.

Sandpaper—Paper covered on one side with glue and then sprinkled over evenly with sand, for smoothing and polishing.

Saturated Steam—See Steam.

Saturation—The condition of being completely penetrated, impregnated or soaked. In chemistry, an acid saturates an alkali, and vice versa, when the solvent can contain no more of the dissolving body.

Saturation, Magnetic—A bar, etc., is said to be magnetized to saturation when the maximum of magnetizing force has been imparted to it.

Saw—A cutting instrument consisting of a blade or thin plate of iron or steel, with sharp teeth on its edge. A set of saws, including handsaws and backsaws, should be found in every well-equipped garage.

Sb.—The chemical symbol for antimony.

Scale—Scale is a deposit or incrustation in the water jackets of cylinders and in the tubes of boilers and radiators. See Incrustation, in Repairs and Adjustments.

Anything graduated or marked with lines or degrees at regular intervals, for purposes of measurement, weighing, etc.

Scarf—A joint by which the ends of two pieces of wood are united so as to form a continuous piece; secured by bolts or straps.

Scarf Weld—A form of welding metals end to end by overlapping.

Scavenging—The cleansing operation performed by the piston of an internal combustion engine in clearing out the exhaust products by its exhaust stroke.

Scour—To rub hard with anything rough for the purpose of cleaning the surface. To cleanse or flush by a stream of water. To clean metal for electroplating, etc., by means of acids.

Scouring Barrel—A machine to free small metal castings from dirt, rust and excrescences by friction; a rumble.

Scraper—A cleaning tool for use on metal surfaces, as for removing carbon deposit from cylinders, etc. A horse-drawn device for leveling roads.

Scraping up and Adjusting Engine Bearings—See Overhauling Hints and Tips.

Scratch Brush—A brush made of fine wire or spun glass, used to clean or polish metals.

Screen, Dust—This is a necessary fitting for some open cars, which are not provided with hoods, as without it both the car and its occupants are bound to be smothered with dust. The best type of screen is one which is collapsible and ·n be removed in a few seconds. When in position no dust should be drawn over the back of the car. In most modern cars the back is so designed that the dust is not sucked in.

Screen, Glass—See Wind Screen.

Screen, Magnetic—In electricity, a closed conductor placed over a body in order to protect or screen it from the effects of external electrostatic fields. Used with galvanometers and other delicate electrical instruments.

Screen, Wind—See Wind Screen.

Screws—There are many kinds of screws used in connection with motor cars, of which the following are the principal:

Adjusting Screw.—An adjusting screw is used to regulate the distance between two members when the operation is too delicate to be performed by hand. The screw usually remains fixed or locked after the adjustment has been made.

Binding Screw.—A screw used for holding a small part or member in place, such as the high tension wire on to a plug or the screws on the terminals of the coil used to secure the wire.

Countersunk Screw.—A screw with a head formed to sink into a recess in the end of the hole into which it is screwed, so as to lie flush with the surface. Such screws always have a slot cut across their heads, so that they can be operated by a screwdriver.

Clamping Screw.—Any screw by means of which two parts are clamped together.

Contact Screw.—A screw with a platinum tip, used to make contact in an electrical appliance, such as a coil or contact maker; also for adjustment.

Double-threaded Screw—A screw having two threads instead of one. The threads are cut parallel with one another. As many as eight threads can be cut on one cylinder, the finished screw being called a "multiple threaded screw."

Fastening Screw.—See Locking Devices, under Bolts and Nuts.

Fixing Screw.—See Locking Devices, under Bolts and Nuts.

Grub Screw.—A small screw without a head, provided with a cross-cut for a screwdriver. It is screwed into the thread, "half and half," parallel with the axis of the bolt, in order to prevent the screwed piece from loosening. It is also used to fasten small bosses or wheels on light shafts, in which case it is known as a spindle screw. See Bolts and Nuts.

Left-hand Screw.—This screw has the thread in a direction such that, to screw it into anything, it must be turned in a direction contrary to the direction of the hands of a clock, and to turn it out vice versa. Left-hand threads are only used in exceptional cases, where the direction of rotation of the part to which the screw, or screwed collar, or nut, or whatever form it may take, would tend to cause it to become unscrewed.

Right-hand Screw.—A screw which has the thread in the opposite direction to that of a left-hand screw.

Set Screw.—A screw, generally with a hexagon head like a bolt, but having no nut; used to hold two parts together by passing through one and being screwed into the other.

Sunk Screw.—Same as Countersunk Screw.

Terminal Screw.—A screw by means of which a wire can be attached metallically to an electrical appliance. It is always insulated. Terminals are found on coils, storage batteries, etc.

Thumb Screw.—See Bolts and Nuts.

Screw, Auxiliary—A screw for propelling a sailing vessel when the wind is adverse.

Screw Band—A form of clip for connecting the leaves of a spring.

Screw Barrel—The stem or cylindrical part of a screw.

Screw Blade—A blade of a screw-propeller.

Screw Bolt—A bolt with head at one end and thread at the other, used with a nut.

Screw Clamp—A clamp which acts by means of a screw.

Screw Contact, Truing Up—See under Ignition.

Screw Die—A die used for cutting screw threads.

Screw Coupling—A coupling in the form of a collar with an internal screw thread at each end, used for joining the ends of vertical rods or chains; also a screw socket for uniting pipes or rods.

Screwdriver—A turnscrew; a tool or instrument for turning screws. Several of different sizes should be carried, as they prove useful for many purposes. See Tools.

Screw-eye—A screw of which the head forms an eye or loop.

Screw Gear—A worm screw and worm wheel or endless screw and pinion. See Gear or Gearing.

Screw, Interrupted—A screw with parts of its thread cut away, forming channels in its length.

Screw Jack—A lifting jack operated by a screw. See Jack.

Screw Joint—A coupling made by means of screw threads.

Screw Key— A socket wrench for turning a nut or screw. A tapering wedge the motion or position of which is controlled by a screw cut lengthwise upon it.

Screw, Lag—A sharp threaded screw made for fastening lags in machinery.

Screw Machine—A machine for making screws from wire or metal rods. A lathe for cutting wood screws.

Screw, Machine—A screw for use in metals as distinguished from a wood screw.

Screw, Micrometer—A fine-threaded screw used for measuring very small spaces.

Screw Pitch—The distance between the center of the threads forming a screw, measured along a line parallel with the axis of the screw.

Screw Plate—A steel plate having screwed holes in it shaped so as to form internal teeth. Used for cutting screw threads on cylindrical pieces of metal, such as rods or bolts. Also called a diestock.

Screw Propeller—A propeller which acts on the principle of a screw. See Propeller.

Screw Rod—A rod with a screw and nut at one or both ends, used for binding or tightening.

Screw Shackle—A shackle of which the shackle-bolt is screwed into place.

Screws, Removing Broken—See under Engines.

Screws, Removing Terminal—See Care of Battery, under Battery.

Screw, Setting-up—A screw for taking up space worn in journal-boxes, etc., an adjusting screw.

Screw-stock—A diestock or screw-plate.

Screw Tap—A tap for cutting interior screw threads.

Screw Thread—1. A helical groove cut into the surface of a cylindrical length of metal to correspond with a similar groove cut in the wall of a hole to receive same. In this way two members can be rigidly joined. These grooves may be either of V section or rectangular section. They are called "V threads" and "square threads" respectively.

2. One turn of the thread or ridge of a screw. Thus we say, fifteen screw-threads to the inch.

Screw, Thumb—A screw having a broad flat head which may be turned by the application of the thumb and forefinger.

Screw, Triple—A screw having three consecutive threads of the same pitch.

Screwed Union—See Union.

Screw, Wood—The ordinary iron or steel screw, having a conical point and spiral threads, for uniting pieces of wood; adapted for forcing its way into wood when turned with a screwdriver, etc., and so distinguished from a "machine screw," which is inserted in metal in a thread made to receive it.

Screw Wrench—See Tools.

Scriber—A tool with a sharp point to use for scribing, that is scratching or scoring a hard surface; also called Scribe, Scribing-awl and Scribing-tool.

Scroll Saw—A very narrow blade or ribbon of steel with fine saw-teeth on one edge, adjusted in a frame and used for sawing out intricate patterns in wood, involving short curves.

Scroll Spring—See Springs.

Scupper—A channel cut through the water-ways and sides of a ship to carry off water from the deck. A hole in an automobile tonneau floor for drainage purposes.

Sea-Cock—Any valve or cock in a vessel's hull that controls connection with the water.

Searchlight—An adjustable gas or electric lamp that projects a powerful beam of light to a considerable distance in any required direction. Such a lamp is fitted to many automobiles. See Lamps.

Seat or Seating—The surface upon which a valve rests when closed.

Seats, Style of—See under Carriage Work.

Secondary Battery—A storage battery or accumulator. See Battery.

Secondary Current—Another term for the high tension current. See Ignition.

Secondary Shaft—See Shafts.

Secondary Wire—See Wire.

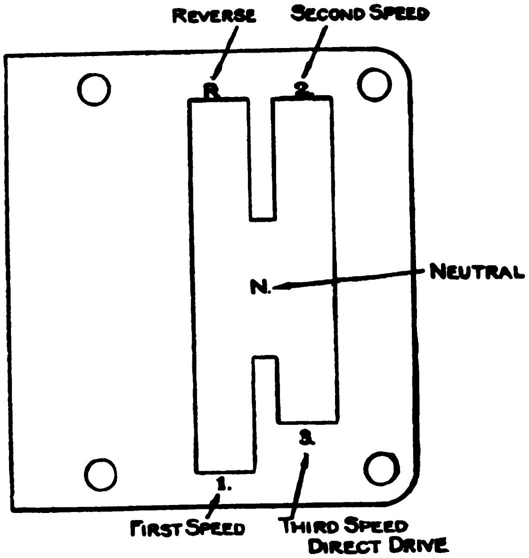
Second-hand Car, Buying a—See Choice of a Car.

Second-hand Car, Testing a—See under Choice of a Car.

Second Speed—The speed which comes next to the lowest in a change-speed combination. See Change Speed Gear.

Sector—A portion of a flat ring of metal. This term is used to describe the notched guides on the steering wheel for the control levers to travel over. The toothed segment used in certain forms of steering gear is sometimes known as the sector. (See Steering.) Also the quadrant over which the control lever for change speed gears moves is often described as the sector.

Sector, Grid—Same as Gridiron Quadrant. See under Quadrant.



Knox Gear Shift Quadrant.

Securing Foot-Mats—See under Foot-Mats.

Security Bolts—See Tire Bolt.

Segment—A part of a circle or circular disk. Insulated segments are used in contact makers and distributers. See Ignition.

The term is applied to any mechanical part having the general shape of the segment of a circle, as a cam or gear wheel.

Segment Valve—A valve shaped like a segment of a circle or seating upon a segment of a cylinder, etc.

Seize—To stick, bind or cohere. When a piston sticks firmly in the cylinder from want of lubrication or otherwise it is said to seize.

In nautical parlance, to seize is to bind, lash or make fast, as one thing to another, by several turns of small rope or cordage.

Seized Bearings—See Miscellaneous Roadside Repairs.

Seized Piston—The condition of a piston when it grips or binds in the cylinder and cannot be easily moved by the usual means.

Seizing—The act of sticking or binding, as a moving part of machinery, through lack of lubrication or other cause.

Seizing-stuff—Small tarred cord used by seamen for seizing.

Selden Patent—The fundamental United States patent on gasolene vehicles, No. 549,160, granted to Mr. G. B. Selden on November 5, 1895; application filed May 8, 1879. The following embodies a brief statement of the claims allowed:

"A self-propelled vehicle comprising steering wheels and steering mechanism, driving wheels, a liquid hydrocarbon engine of the compression type, the engine shaft running at a speed greater than the driven wheels, and disconnecting means between the engine and the driven wheels, the engine being such as to permit the inclusion in the combination of a body adapted for persons or goods."

There were six claims in all, some of the other claims relating to other features of construction. The claims summarized above, however, cover all the combinations of the elements which have been found essential and which are today embodied in one form or other in all so-called gasolene automobiles. The patent will expire November 5, 1912.

Selective—Using that which is selected or chosen. Applied to a system of variable speed gear.

Selective Type Transmission—The modern system of transmission by which varying speeds can be maintained at the will of the driver by the operation of a single lever. See Selector Bar.

Selector Bar—In modern types of change speed gear, where two pairs of sliding wheels are used, operated by one lever, mechanism is necessary to select which pair of gear wheels shall be put into connection by the hand-operating lever. For this purpose sliding bars are often used, and the lever is arranged to engage with one or the other of these, according to which pair of wheels is to be moved. The ends of the bars terminate in forks which engage with collars on the wheels, so that when the bar is moved the wheels are moved along the shaft. See Gate Control Mechanism, under Change Speed Gear.

Selector Lever—In some cases, instead of selector bars, selector levers are used having forked ends. The end of the hand-lever, or the lever connected with it, is arranged to engage with one or the other of these according to which set of wheels is to be used.

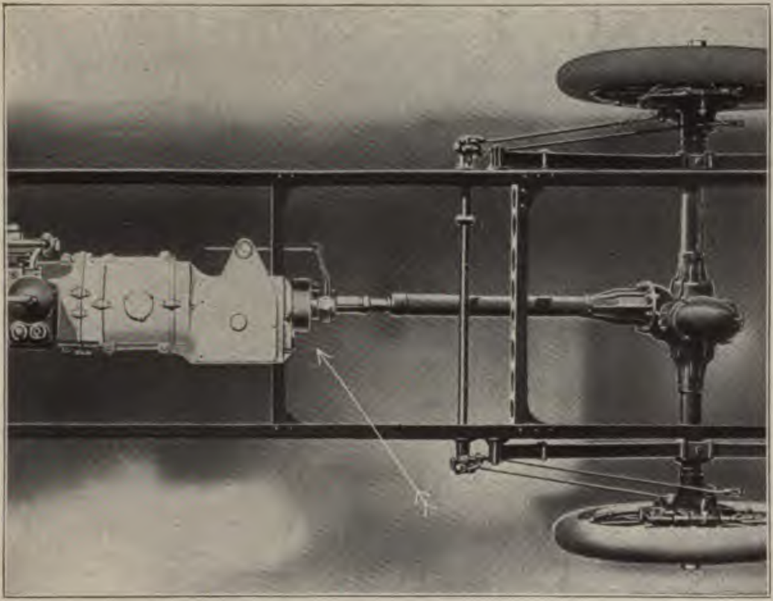
Selector Rod—Same as Selector Bar.

Self-contained—In mechanics, applied to a machine complete in itself as to motor power and operating parts. Thus a self-contained steam engine is an engine and a boiler connected, complete for operation; similar to a portable engine but without the traveling parts. An automobile is a perfect example of a self-contained machine.

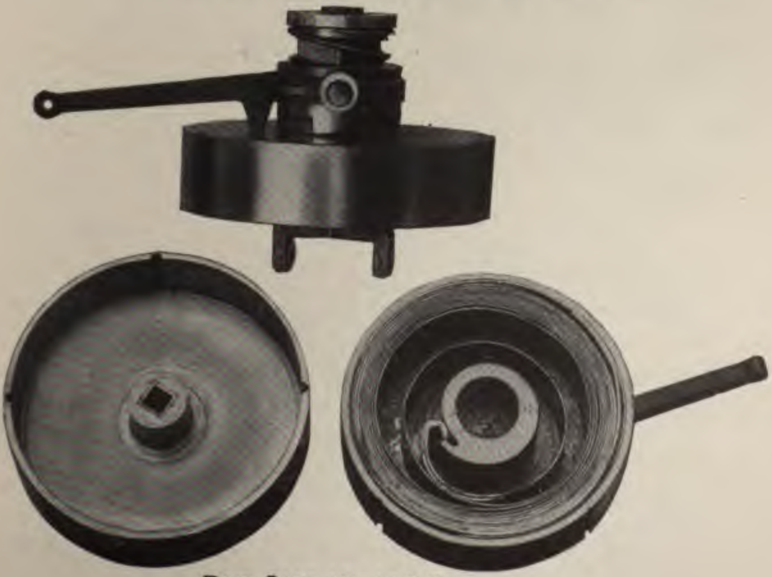
Self-firing—Self-firing or self-ignition after the current has been interrupted is due to the heat of the cylinder head being increased by the compression up to the igniting point of the gas. On motor bicycles this is due to the motor being placed in an insufficiently exposed position, to the gills being too small, and to over-lubrication, which tends to deposit soot in the head. This soot is a bad conductor, and therefore keeps the heat and gets hot enough to ignite the gas. See Overheating.

Self-Ignition—The ignition of the charge in a cylinder by some other means than that of the spark. Usually caused by red hot soot or great heat in the cylinder.

Self-Induction—The production of an electric current from the effects of the magnetic field produced by another current which is passing in another direction. If a coil of wire through which a current from a battery is passing is revolved between the poles of a magnet, currents in an opposite direction will be induced in the coil by self-induction. Also called Auto-induction. See Coil; Ignition.



The Gardner Self-Starter for Automobile Engines.
(A Spring Device of Four Simple Parts.)



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Self-Starter—An automatic starting device or apparatus to enable the driver to start his engine from his seat. Several types are on the market, some using compressed air and compressed gas charges, others operating by means of a coiled spring, etc.

Self-tuition in Driving—See under Driving.

Semi-elliptic Springs—See Springs.

Series, In—One of the methods of connecting up a number of cells so as to attain a desired result. See Battery.

Serpollet Steam Engine—See Steam Car, under Motor Car.

Set—A permanent change of figure caused by pressure or being retained long in one position, as the set of a spring.

The lateral deflection of a sawtooth.

A carpenter's punch for driving a nail below the surface of the wood.

A punch for setting the teeth of a saw.

A narrow chisel-like tool used by metal workers for chipping grooves in metal.

A broad chisel-like tool used for cutting off hot or cold bars on the anvil.

A hook-wrench or form of key, spanner or screw-wrench used for turning bolts, etc.

Set-bolt—A bolt used to drive another bolt out of its hole.

Set Nut—Any nut set against another to hold it securely in place.

Set Off—See Offset.

Set, Riveting—A hollow-faced punch for shaping rivet-heads, the hollow being of the shape which it is desired to give to the head of the rivet.

Set, Saw—An instrument used to turn the teeth of saws alternately to the right and left so that they may make a kerf somewhat wider than the thickness of the blade.

Set Screw—See Screws.

Setting the Governor—See Governing and Governors.

Setting of Valves—See Overhauling Hints and Tips.

Shackle—An iron or steel link closed by a movable bolt. One of the joints formed by links and bolts and nuts by means of which the chassis frame is hung on the ends of the axle springs.

Shackle Bearings, Lubricating Spring—See under Lubrication.

Shackle Joint—See Joints.

Shafts—A shaft in machinery is a revolving member which transmits power. Shafts are of different types to suit the different conditions under which they work. The shafting in a machine shop affords a good example of the simplest form. A shaft used for this purpose consists of a long length of plain cylindrical steel upon which pulleys are mounted which drive the machines, or other shafts, by means of belts. The principal shafts used in motor-car construction are as follows:

Camshaft—A revolving shaft carrying cams. In the case of motor cars the term is applied to the half-speed or two-to-one shaft which carries the cams operating the valves or low tension magneto mechanism for breaking contact. See Cam; Internal Combustion Engine.

In a typical camshaft for a four-cylinder engine the shaft is turned, with its cams and collars, from one solid piece of steel, all the bearing and wearing surfaces being ground true after the shaft is hardened. There is a tapered end, to which is fitted any appliance which has to be driven by the cam shaft, such as the pump or fan. At the other end is the gear wheel, which is driven by a pinion on the engine shaft half its size, and so drives the camshaft at half the speed of the engine. On the inside of the gear wheel are two lugs, to which the governor balls are pivoted. Two collars solid with the shaft locate it in its bearings and prevent it moving endways. In the center of the shaft is a helical or skew gear wheel which drives a similar wheel on a vertical shaft, at the top of which is mounted the contact maker. The cams are eight in number, four of them operating the inlet valves and four the exhaust valves.

The reason for calling the camshaft a "half-speed shaft" is that the shaft is driven by means of gearing at half the speed of the crankshaft, as described under Internal Combustion Engine. That is to say, for every two revolutions of the crankshaft the camshaft only makes one. It is only necessary to operate each valve once during every two revolutions of the crankshaft, and this method of gearing is employed to lift the valve at the correct time. The camshaft is also used to vary the lift of the valves, or to give half compression as described under Cam. In the case of low tension magneto ignition the contact breaker is operated by cams in the same manner. See Ignition. Also the ordinary contact maker or make-and-break device for high tension ignition is usually driven by the camshaft.

Cardan Shaft—Where two shafts are not in line with one another, or when their position in relation to one another varies, and one has to drive the other, an arrangement called an arbor or cardan shaft is used to connect the two. This shaft is fitted with universal joints at each end, so that it can adapt itself to the inequalities of the drive. Cardan shafts are also used to transmit power from the gear box to the rear live axle, and are then sometimes referred to as propeller shafts.

Countershaft—An intermediate shaft, taking power from one shaft and transmitting it to another by means of chains, gearing or belts. The term is usually applied to the shaft which crosses the car and carries the chain sprockets on its extreme ends, being driven by means of bevel wheels from the gear box. See Motor Car. The term is also applied to the secondary or lay shaft in the gear box. Also called Jackshaft. See Secondary Shaft.

Crankshaft—The shaft which receives the impulses of the piston, the cranks converting the reciprocating motion of the pistons into rotary motion. The throw of the crankshaft is the distance between the center of the crankshaft and the center of the crank pin, this distance being, of course, half the stroke of the piston. The power from the crankshaft is usually transmitted to the gear-box via the clutch.

Cross Shaft—A shaft which transmits power from another shaft while its axis is at an angle to the axis of the shaft driving it. It is a term usually applied to the countershaft of a car.

Engine Shaft—See Crankshaft.

Flexible Shaft—A means of connection between two members capable of transmitting power from one to the other through any angle or angles whatever. It usually takes the form of a tubular spiral through the bore of which runs a flexible wire. The outer tube is fixed at each end, while the power is transmitted by the inner wire. It is used to a great extent in speedometers. A chain sometimes takes the place of the inner wire when the bends are not too acute. In the case of pumps, the spindle is sometimes driven by using a stiff spiral spring as a shaft between the pump spindle and the shaft driving it. In this case, should the pump itself jam for any reason, the spring will relieve the shock.

Gear Shaft—A gear shaft carries gear wheels or pinions which mesh with gear or pinion wheels carried on another shaft. In a gear-box, for instance, there are usually two gear shafts, one called the primary, being connected to the clutch and thus receiving its power from the engine, the other called the secondary, lay or countershaft, being connected to it by gear wheels and transmitting the power to the road wheels. See Change Speed Gear.

Half-speed Shaft—See Camshaft.

Hollow Shaft—Many crankshafts are now made hollow, as also are some other shafts, such as rocking shafts.

Intermediate Shaft—A term applied to any shaft which transmits power from one shaft to another either by means of belts or gears. The name is generally used in connection with the secondary gear shaft. (See Secondary Shaft.)

Jack Shaft—Same as Countershaft or Cross Shaft.

Lay Shaft—The same description applies to Lay Shaft as to Intermediate Shaft. See Secondary Shaft.

Motor Shaft—See Crankshaft.

Primary Shaft—The shaft in the gear-box which takes its power from the engine and transmits it to the secondary shaft. See Change Speed Gear.

Propeller Shaft—This is the shaft which transmits the power from the gear-box to the back live axle. It is provided with universal joints at either end, so that it can adapt itself to the varying angle between the gear-box and the axle due to the motion of the springs. See Joints; Motor Car; Transmission.

Reversing Shaft—The small shaft in the gear-box which carries the reversing gear wheel; really an intermediate shaft.

Secondary Shaft—The shaft in the gear-box which transmits the power from the primary shaft to either the propeller or countershaft, or back to the primary shaft. See Transmission. It is sometimes called a lay shaft, countershaft, intermediate shaft, or gear-shaft.

Torsion Shaft—The shaft that runs through the center of a live axle transmitting the drive from the differential gear in the center of the axle to the road wheels. This shaft is really the "live" part of a live axle, the tube or axle proper through which it runs being used solely to support the springs on which the body rests.

Transverse Shaft—A shaft set at an angle to another shaft. The countershaft is a transverse shaft.

Two-to-one Shaft—Same as camshaft. See Camshaft.

Shaft, Drive—A propeller shaft.

Shaft-eye—A hole in a shaft through which a pin or bolt is passed.

Shaft, Half-speed or Half-time—Same as Camshaft. See under Shafts.

Shafting—The system of shafts connecting a machine with the prime mover and through which motion is communicated.

Shaft, Jack—See Jackshaft, under Shafts.

Shaft, Propeller—A name loosely applied to any shaft in a car which transmits the engine's motion to the road wheels and is arranged lengthwise along the length of the car. The idea is derived from the shaft which drives the propeller of a ship. See under Shafts.

This shaft generally starts at the back of the gear-box, where there is a universal joint, and finishes in the bevel wheel bearing inside the differential case. The foot brake is frequently arranged to act upon a piece which is flexibly coupled to this shaft.

Shaft, Square—A length of square shafting; used in sliding gear.

Shaft Sprung—See under Pounding and Knocking.

Shaper—In metal working, a combined lathe and planer used, with attachments, for a variety of purposes. A stamping-machine for sheet metal.

Shearing—The operation of producing a shear, which in dynamics is a strain consisting of a compression in one direction with an elongation in the same ratio in a direction perpendicular to the first. A "complex shear" is a strain compounded of two or more simple shears. Such strains are frequently set up in machinery and result in cutting or shearing action by adjacent parts. Any simple strain may be resolved into a shear.

Shears—An instrument consisting of two movable blades with bevel edges, used for cutting cloth, etc.; a heavy form of shears is used for cutting sheet metal.

Shear Steel—Blister-steel treated by a process of drawing. The uniformity and density are increased by this process and the product is so-called because used in the manufacture of shears, knives, etc. Blister-steel is made by heating iron in a furnace in contact with charcoal. After being converted into steel the bars become covered with blisters of varying sizes.

Sheave—A grooved wheel in a block, mast or yard, on which a rope works; the wheel of a pulley.

Sheet Metal—Metal which is rolled or formed into sheets, as sheet iron, sheet zinc, tin plates, etc.

Shell—Any framework or exterior structure, regarded as not being completed or filled in; the outer skin of a boiler, the casing of a pulley block, etc.

Shellac—A product of lac, a resinous substance obtained by exudation from certain trees. When melted and reduced to a thin crust it is known as shellac. It is easily melted, forms a good insulator, and is used to coat the windings of coils to prevent them from being attacked by damp or wet. It is also used as a varnish, and is soluble in naphtha and methylated spirits.

Shield—A metal pan for the protection of the power-plant or gear of an automobile from dust, mud, etc.

Shield for Engine and Gear-Box—See Gear Protection.

Shift Lever, Gear—See Operating Mechanism.

Shim—A thin strip of metal, wood, etc., used in a worn place or between parts of machinery that may wear, to fill the space; hence, any piece used to make a tight fit.

Shock—A violent concussion of one thing against another; a sudden striking against or violent collision.

Shock Absorbers—The generic term applied to devices for the absorption or elimination of the shocks and vibration caused by the reaction of springs on a car body. See under Springs.

Shoe, Brake—That part of a brake which is brought directly in contact with the wheel, hub or drum on which it acts to retard progress.

Shoe, Tire—The outer casing of a pneumatic tire.

Shooting—In carpentry, the operation of planing the edge of a board straight.

Short—Brittle or inclined to break or crumble easily; used of metals, etc. Iron is made "cold-short" by phosphorus and "hot-short" by sulphur.

"Short" is also a motorist's abbreviation for "short circuit."

Short Circuit—By this term is implied the formation of a short path for the current in an electric circuit, so that it flows by this in preference to going in the right direction.

As the pressure in volts has been provided for the purpose of sending the current through a certain amount of resistance, such as coil winding, when the current finds a short path in which there is no resistance, it becomes enormously increased, and may fuse the wires through which it is passing or harm the battery which may be the source of the current. The current in a circuit may also find an auxiliary path which is not a short one, and which may have some resistance in it, so that only a portion of the total current may pass through it. This is a shunt circuit, or partial short circuit, and would have the effect of merely weakening the spark without entirely destroying it. Such circuits are formed by rain-soaked wires, cracks in the insulation making a circuit through parts of the frame, etc., and are sometimes very troublesome. See "Short Circuits," in Repairs and Adjustments.

Short Circuit to Frame—See under Ignition.

Short Circuiting at the Switch—See under Ignition.

Short Circuiting, Commutator—See under Ignition.

Short Circuits—See Misfiring, Causes and Treatment.

Short Circuits, Detecting—See under Ignition.

Short Circuits, Test for—See under Ignition.

Shoulder—A projection on the axle of a vehicle; a boss on a shaft, etc., for the attachment of another part or member.

Shunt—A shunt in an electric circuit is a cross path or by-path through which some of the current in the main circuit may flow, the amount of the current flowing being determined by the resistance of the conductor of which the shunt is composed. The condenser on an induction coil is practically a shunt. A shunt may be connected in the circuit in two ways: First, where it forms a by-path on one wire, and, second, when it forms a cross path between the positive and negative wiring. In practice the effects of both methods of arranging the shunt are the same. See illustration under Ignition.

Shut—The place where two metallic substances are joined by welding.

Shutter—A removable cover or gate for cutting off the supply of metal from a mold. A device for regulating the supply of air to a carbureter.

Side Chain Drive—See Transmission and Variable Gearing, under Change Speed Gear.

Side Chains—The chains used to transmit power by means of sprockets in a chain-driven car.

Side Lever—A lever placed at the side of the car and the driver, to operate the change speed gear, brakes, etc.

Side Light—An automobile lamp placed on the side of the car.

Side Member—One of the two longitudinal members of a motor car frame.

Side-slip—The lateral movement of the wheels of a car which have lost their grip on the road surface. It really should not be confused with "skidding," which refers to the fore-and-aft slipping movement, but the two terms are often used as synonymous. See Skidding or Side-slip, under Driving.

Side-slip Downhill, to Avoid—See under Driving.

Side-slip, Sources of—See under Driving.

Sight-feed Lubricator—See under Lubrication and Lubricators.

Sight Test—A device including a glass tube fitted to the "feeds" of a mechanical oiling system, by which the efficient working of each feed may be tested.

Silencer—Same as Muffler, which see.

Silencing the Exhaust—See under Internal Combustion Engine.

Silicon—A non-metallic element occurring widely distributed in nature as silica and in the form of silicates. It resembles carbon in its chemical action. Valuable in making alloys, as silicon-brass, silicon-bronze, etc.

Silicon Iron—Iron containing a large proportion of silicon, [illegible]. Also called Ferro-silicon.

Sill—One of the principal side-members of a chassis frame.

Silver—A [illegible] of the [illegible] brilliancy, of specific gravity [illegible] and atomic weight [illegible]. It is hard, [illegible] and ductile, not affected by air or moisture, but tarnished or blackened by sulphuretted hydrogen. The best known [illegible].

Simms and Bosch Ignition Systems—See under Ignition and Magneto.

Single-Acting Engine—Any engine or prime mover in which the motive power is applied in one direction only, the motion in the opposite direction being effected by momentum or other extraneous form of power.

Single-Chain Drive—A form of chain drive in which only one chain is employed to transmit the power to the road-wheels.

Single-Cylinder Cars, Driving in Traffic—See Driving.

Single Engines, Starting—See Starting the Engine, under Driving.

Siren—A powerful signal whistle or horn.

Six-Cylinder Engines—See Multi-cylinder Engines, under Internal Combustion Engine.

Skew—An oblique or twisting motion.

Skew Gear—A form of bevel gearing for shafts lying at an angle to each other and in different planes. Also called Screw Gear. See under Gear.

Skid—Strictly speaking, this term should only be used to describe the slip of the driving wheels when they refuse to bite, as distinguished from the lateral movement caused by side-slipping. See Driving; Tires. The term, however, is also loosely used to describe the lateral movement more correctly described as side-slipping. See Side-slip.

Skidding or Side-slip—See under Driving.

Skidding, To Avoid—See under Driving.

Skill in Driving—See under Economizing Gasolene.

Skin—The thin film of hard metal on the surface of a casting or forging, owing to the chilling or hardening of such surfaces against the sand or by contact with the air. The casing covering the ribs of a ship or boat.

Slack Chains, Driving with—See under Driving.

Slack in Throttle or Spark Connections—See under Useful Information.

Slag—The dross of a metal; also the vitrified cinders of a furnace.

Slag Wool—Silicate cotton, sometimes used as a non-conducting material for protection of steam-pipes.

Sleeve—A tubular covering on a shaft, sometimes free to slide lengthwise along it, as used in gear-boxes to carry the sliding gear wheels. See Change Speed Gear.

Also a short tube connection usually with right and left hand threads.

Sleeve Coupling—A sleeve-nut or a short, threaded, tubular connection for rods, pipes, etc.

Sleeve Joint—A connection made with a sleeve.

Sleeve Nut—A double nut with right and left hand threads for connecting the joint-ends of rods or tubes; a union.

Sleeve, Tire—See Tire Sleeve.

Slew—To swing or slide to one side; used of a vehicle on making a quick turn. Also spelled Slue.

Slide Bar—The guide-bars of a box or cross-head in a steam engine.

Slide-box—The slide-valve chest of a steam engine.

Slide Rod—The rod which moves the slide valve in a steam engine.

Slide Valve—A valve which opens or closes by sliding over a port or ports. See Valves.

Slide-Valve Ignition—See under Ignition.

Sliding Contact—An electrical contact which is connected with one part of a circuit and closes that circuit by being slid over a conductor connected with another part of the circuit. See Timing.

Sliding Feather—See under Feather.

Sliding Feather Gears—See under Change Speed Gear.

Sliding Friction—See Friction.

Sliding Gear—See Change Speed Gear.

Sliding Sleeve—See Sleeve.

Slip—See Side-slip.

Slip Clutch—A form of coupling or clutch containing a friction-band which slips round on its pulley until the friction becomes equal to the resistance and the pulley gradually attains the same motion as the clutch.

Slip Joint—A term applied to a compensating or universal joint.

Slipping Clutches—See under Clutch.

Slopes or Grades, Coasting—See under Driving.

Slot—In machinery, an elongated narrow depression or perforation; a rectangular recess or depression cut partially into the thickness of any piece of metal for the reception of another piece of similar form, as a keyseat in a shaft, wheel or pulley.

Slow Speed Gear, Returning to—See under Driving.

Smell—As a rule smell is due to a foul exhaust, caused from either too rich a mixture or a surplus of lubrication in the cylinder. The remedy for either complaint is obvious, and if an engine is running properly the exhaust gas will be almost odorless.

Occasionally smell is caused by oil on the outside of the exhaust pipe or engine evaporating, but this ceases when the engine has been running some time. The same thing is sometimes observed with air-cooled engines through oil getting on the cylinders. After starting an engine that has been previously flushed with kerosene to free the piston rings, the exhaust is visible, and smells badly for a short time. See Smell from Cars, under Lubrication.

Smoked Goggles, Use of—See Goggles.

Snap—A tool used for shaping the head of a rivet; a rivet-set.

Snap Cam—A cam used for closing the circuit in an ignition system.

Snap-head—A rounded head of a rivet, bolt or pin.

Snifting Valve—A valve in the cylinder of a steam engine for the escape of air; so called from the noise it makes.

Snips—Heavy hand-shears used in cutting metal.

Snug—A small rib, lug or marginal ridge cast on a plate and acting as a lateral support to keep an attached object in place.

One of the catches on the eccentric pulley and intermediate shaft of a steam engine, for the purpose of communicating the motion of the shaft through the eccentric to the slide-valve.

Snug Bolt—See Bolts and Nuts.

Soap—Various kinds of special soaps are made for motorists to remove oil and grease from the hands. The best are those which contain no gritty matter.

Soapstone—A species of steatite, a mineral consisting of magnesia and alumina. It is used in the manufacture of porcelain, and forms a most valuable non-conducting material capable of withstanding great heat without becoming brittle. It is utilized in such appliances as sparking plugs and low tension igniter plugs, which have to withstand the full heat of the exploding gases.

Socket—A part into which some other part fits. Sockets, screwed internally, are used to connect pipes, and are also used in ball and socket joints in steering gear and other control mechanism.

Socket Joint—See Joints.

Socket Wrench—A wrench arranged to unscrew or screw up caps with sunk squares, such as are used on the heads of valve chambers. See Pipe Wrench, under Tools.

Soft—Easily susceptible of change of form, hence easily worked, malleable, as soft iron, etc.

Soft Solder—A solder that melts at comparatively low temperature.

Soft Tires—See under Loss of Power.

Solder—This term is used to denote the alloy, commonly of one part tin and two parts lead, which is used for the purpose of joining brass, copper or tinned articles together, which operation is known as soldering.

Solder, Aluminum—An alloy of gold, silver, copper, etc., used in soldering aluminum bronze.

Solder, Hard—Solder which fuses only at red heat and is therefore used for joining brass, iron and the more refractory metals. Spelter solder and silver solder are varieties of hard solder.

Solder, Soft—See Soft Solder.

Soldering—The joining together of two pieces of metal by running between them a molten alloy of tin and lead. Ordinary soldering can only be properly accomplished where the metals to be joined are either tinned iron, commonly known as tin, or copper and its different alloys, such as brass. Soldering is distinctive from brazing, in that it is not necessary to heat the two parts to be joined, except only to a very low temperature, and the process may be carried out by means of a blowpipe or by any very hot conductor of heat, such as a copper bit, known as a soldering iron. In order to cause the solder to flow it is necessary to have some sort of flux. The object of the flux is to surround the surfaces to be joined with a layer of liquid which excludes the oxygen of the air, otherwise the metals to be joined would not be properly amalgamated with the solder joining them. In the case of joining copper articles the best flux is sal ammoniac in its crystal form. In the case of tinned iron and brass spirits of salts may be used, which has previously been what is termed "killed," by dissolving in it as much zinc as it will hold in solution. Resin or rosin is also frequently used as a flux in soldering.

In soldering any two parts together the first object should be to get both surfaces absolutely clean and bright. Any grease should be rigidly excluded, as it prevents both the action of the flux and the proper running through of the metal alloy used for soldering. The most convenient method of soldering is by means of the copper bit or soldering iron. This is constructed of copper solely because it will collect the heat quicker than any other metal, and it gives it off very rapidly, which is necessary in order to heat the surface to be soldered so that the solder may flow easily and rapidly. The end of the copper bit is generally amalgamated with tin or solder, and if the soldering iron is not heated above a temperature which would tend to make it become red the tinning will not melt off, no matter how many times it is put into the fire. It is useless to solder with a copper bit unless the end of it is first tinned, which is the technical name for amalgamating it with tin, as we have mentioned.

Soldering is one of the easiest methods of joining two metals together, and is most useful in motor car work in connecting up wires and in joining the sides of tanks and in repairing them. It is a particularly easy operation, the great point to insure being absolute cleanliness, bright surfaces to be joined, and a soldering iron at the right heat and always well tinned.

Soldering, Autogenous—A method of uniting metals by fusion of the parts to be joined, instead of by the use of other materials, as solder and fluxes.

Soldering Flux—Any substance or mixture used to promote the fusion of metals, as resin, etc. See Soldering.

Soldering Iron or Bit—An appliance for soldering which every motorist should carry. See Soldering above.

Soldering Lamp—A blowlamp burning spirit or oil, used instead of a soldering bit to make a soldered joint. With it the heat can be more concentrated, and a greater temperature obtained.

Solenoid—A helical coil of wire, of uniform diameter and cylindrical in form; used as a magnet.

Solid Tire—A tire for motor vehicles, composed of solid rubber, as distinguished from a pneumatic tire.

Solid vs. Pneumatic Tires—The respective merits of solid tires and pneumatic tires have long been a subject of controversy and each kind has its warm friends and supporters. The following article on the subject by Mr. J. A. Swinehart of Akron, Ohio, an authority on tires, is of general interest. It originally appeared in the Scientific American in regard to certain comparative tests of the two types of tires:

"I am prompted to give a little of my experience as the patentee of twenty-two different types of both solid and pneumatic tires and as the promulgator of crosswire tires which now are well known in all countries on the globe and which tires constitute no less than 90 per cent of all solid tires used on motor-driven vehicles.

"Before commenting upon the report on tests made, I wish to say that we will admit generally that there is no tire as easy riding and that will cause less vibration on a motor-driven vehicle than a pneumatic tire, provided the same is not too highly inflated.

"In reporting tests, however, between solid and pneumatic tires, it is the plain and honest duty of the reporter to state at what pressure the pneumatic tire was inflated when the test was made, as well as the solidity to which the solid tire was cured and the shape thereof. Solid tires can be cured to such a carrying capacity that one cubic inch will carry 500 pounds without yielding ¼ inch, while it can be also cured so that a cubic inch of rubber will only carry 5 pounds to yield the same distance, and without the reporter giving the consistency or carrying capacity to which the solid tire was cured, the report is of no account and cannot be used to enlighten the inexperienced.

"The writer's experience has proven that a solid tire not properly formed, that is cured so hard that it will, on a rough pavement, bounce from one cobblestone to the other and will not keep down to the roadbed, is very little better than a steel tire; but on the other hand when the tire is molded in such a manner that there will be one portion of it always compressed, so that when the wheel strikes an obstacle in the road (which has a tendency to raise the wheel off from the roadbed), this portion of rubber will pop down and keep in contact with the roadbed and prevent the wheel, which would be off the ground, from acquiring a very high speed while the car almost comes to a standstill, thus losing power and grinding off rubber unnecessarily when the wheel again comes down to the earth, will show entirely different results.

"We insist that solid tires must be kept down to the pavement in order to ride comfortably and in order that you can acquire a high speed. It is no difficult task whatever to acquire a speed of from 25 to 45 miles an hour on solid tires, provided there is a bead on the tread of the tire which will, with a normal load, be compressed to the extent of ½ inch, so that when you strike an object that has a tendency to raise the wheel ½ inch, this bead can relieve itself and assume its normal shape and reach down and keep the wheel in contact with the road.

"The writer had at one time designed tires that were placed on high-speed cars capable of running 50 miles per hour. The tires were smooth treads and cured rather hard. They were cured with a view of acquiring carrying capacity rather than comfortable or fast riding and it was impossible to make more than from 18 to 19 miles per hour on reasonably good pavements, as the tire was off the pavement nearly half the time, and when it would come down the tire had acquired such a speed that when the wheel struck the pavement it was as though an emery wheel would come in contact with a piece of chalk—the roadbed would grind the face of the tire down so that there soon would be nothing left on the rim.

"Finding this unsatisfactory, we removed the tires and placed upon the same wheels tires with a center bead measuring about ½ inch high. This bead was compressed completely out of sight as the car stood on the pavement.

"While running the car, we found it a very easy matter to acquire a speed of 40 miles per hour over the same pavement on which it was impossible to get a speed of 20 miles per hour with the hard, smooth-face tire, and we would acquire this 40-mile speed with less fuel than was used with the hard tires when we were scarcely making 19 miles per hour.

"After having made this experiment, and found that the speed to be acquired on solid tires depends upon the tires being softly cured and provided with a bead that would quickly adapt itself to the unevenness of the roadbed, we have decided that the art of successfully making use of solid tires will depend greatly upon the judgment exercised in shaping and curing the rubber and the proper application of the same to such loads as they are adapted to. All solid tires should be loaded, in order to acquire a rapid speed (without too much vibration) to nearly their full carrying capacity, with good buoyant springs between the axle and body of the car. Tires for electric cars used on pavements generally should have narrow treads.

"My experience has also led me to believe that while pneumatic tires generally prevent vibration, they can be inflated so highly and solid tires can be cured so softly and built so high above rim that when the two are passing over the same obstacle side by side at the same speed, the pneumatic tire will rise 50 per cent higher in passing over the obstacle than the solid tire will, and consequently cause more vibration."

The main points of the argument for pneumatic tires are stated elsewhere. See under Pneumatic.

Solution, Rubber—See under Rubber.

Soot—A black substance consisting chiefly of carbon formed by combustion or disengaged from fuel in the process of combustion.

Sooting of the Plug—See "Spark Plug," in Repairs and Adjustments.

Sooty Plugs, Cleaning—See under Ignition.

Sources of Current, Ignition Failure from—See under Ignition.

Spanner—A screw-key or screw-wrench; an iron instrument for tightening up or loosening the nuts upon screws. See Tools, etc.

Spare Parts—Parts or accessories required for repairs or renewals. See Tools, Spare Parts and Accessories.

Spares—A short term for "spare parts."

Spare Tubes, Advantages of—See under Care and Maintenance.

Spare Wheel—See Wheels.

Spark—The flame generated by the system of electric ignition and which ignites the charge. See Ignition.

Spark Advanced—See under Pounding and Knocking.

Spark Coil—See under Coil.

Spark, Fat—See under Fat.

Spark Gap—A term applied to a small appliance used to make a break in the high tension circuit, so that before the spark is formed at the plug the current has to jump this gap.

The principle upon which the use of a spark gap is founded was applied to induction coils of large size many years ago, but the use of the gap in the high tension circuit in an ignition system on automobiles is open to question, and there should be no need for it. The effect of the gap is to increase the air resistance of the high tension circuit, and it may increase the intensity, but as it decreases the quantity of current in the high tension circuit the benefit to the spark is only apparent when it requires greater intensity.

Spark Intensifier—See Spark Gap and Intensifier.

Spark Lever—See Operating Mechanism.

Spark Plug or Sparking Plug—A specially constructed plug screwed into the head of a cylinder to provide a gap across which the high tension current may jump, producing a spark sufficiently hot to ignite the charge.

It consists of a metal body having a core of non-conducting material, such as porcelain or mica, through which passes a rod. The gap is between the end of this rod and the body of the plug. Attached to the outer end of the central rod is the high tension wire conveying the high tension current from the coil. The body of the plug forms the ground return via the cylinder and frame of the car. See Ignition.

A Form of Spark Plug.

Spark Plug, Magnetic—See under Ignition.

Spark Plug Cut-out, A Simple—See under Ignition.

Spark Plug Joint, A—See under Ignition.

Spark Plug Porcelain, Warped—See under Ignition.

Spark Plugs, Periodical Examination of—See under Ignition.

Spark Plugs, Setting up New—See under Ignition.

Spark Plug Troubles—See under Ignition.

Spark Plug, The—See under Ignition.

Sparks, Testing Ignition—See under Ignition.

Specifications, Body—See under Carriage Work.

Specific Gravity—Specific gravity denotes the relative weight of a liquid or gas compared with its bulk, and is calculated by comparing it with the weight of distilled water at a temperature of 40 degrees Fahrenheit. The higher the temperature, of course, the less the weight, but this is taken as a standard in measurement. Thus, sulphuric acid, being heavier than water, has higher specific gravity, being 1.84 of that of water.

The subject of specific gravity is generally interesting to the automobilist in order that he may be able to determine the right quality of gasolene for combustion, and the right quality of acid for the battery cells. The specific gravity of gasolene, however, is not a conclusive test of its efficiency, its evaporative qualities being more important. In determining the specific gravity, an instrument is used called the hydrometer, which floats in the liquid to be tested at certain heights, according to its density. The reading of the hydrometer should always be taken in connection with a temperature reading from an accurate thermometer, as the specific gravity, as shown by the hydrometer, will vary according to temperature.

The specific gravity of the sulphuric solution used in batteries should lie between 1.150 and 1.250, and may be varied by diluting the acid with distilled water. See Battery; Gasolene.

Speed—Rate of movement or progress, whether swift or slow; velocity. See Acceleration; Retardation.

Speed, Angular—The rate at which a body revolves around a fixed axis.

Speed Changes, Gears Missing in—See under Driving.

Speed Changing—See Change Speed Gear; also Driving.

Speed Cone—In mechanics, a contrivance which regulates by means of a belt the ratio of velocity communicated between parallel shafts.

Speed Gear—A gear or gearing by which variable speeds are secured. See Change Speed Gear; also under Gear.

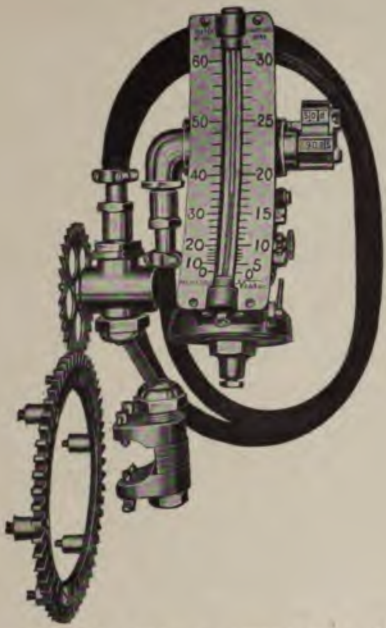
Speed Gears, Variable—See Change Speed Gear.

Speed Indicator—Also called Speedometer, Motormeter, Autometer, Tachometer, etc. A device which shows the speed at which a car is traveling.

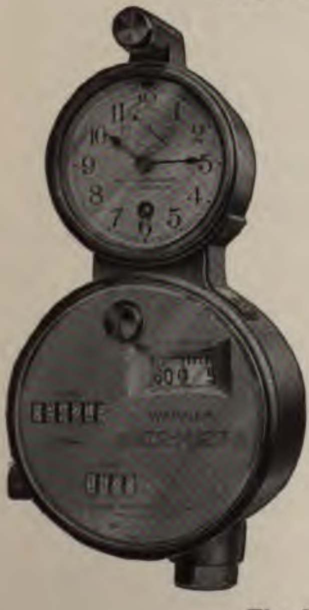
The most common type takes the form of a circular dial fitted to the dashboard in full view of the driver. The mechanism behind the dial is driven, by means of a flexible shaft, by the front road wheels, a gear ring being fitted to the spokes of the wheel and meshing with a gear wheel on the end of the flexible shaft. This pinion is carried by an adjustable bracket clamped to the front axle. The mechanism proper varies in different designs. One type of mechanism consists briefly of a vertical spindle on which two balls are mounted. These balls are free to swing out from the spindle, so that the greater the speed of the spindle, the greater the distance to which the balls fly out. The arms carrying the balls are brought back to position by means of springs, against which the centrifugal force of the balls is always acting when the indicator is running. As the arms fly out they raise, by means of links, a collar sliding on the spindle; this collar in turn works directly on to the pointer which moves across the dial. It will be seen from this description that the faster the car runs the farther will the balls fly out. Consequently, the sliding collar on the spindle is raised to a greater extent, carrying the pointer across the dial in exact proportion to the speed of the car.

A speedometer which has met with a considerable amount of success in Europe and America, and which was awarded the first prize in the Royal Automobile Club (England) contests for speedometers, is the "Jones." It operates like a great many other speedometers by means of a centrifugal governor, which acts against the resistance of a spring as the speed rises, and, though delicate mechanism, operates a hand or pointer on a dial. One advantage of the Jones Speedometer is that it incorporates in the same mechanism the mileage register, and also has a maximum hand, as shown. This hand will record the maximum speed traveled by the car, and will remain at the maximum speed. The smaller hand registers the speed at any particular time. In this speedometer, also, attention has been paid to the arrangement of the drive, so that there are no sharp corners for the flexible driving shaft.

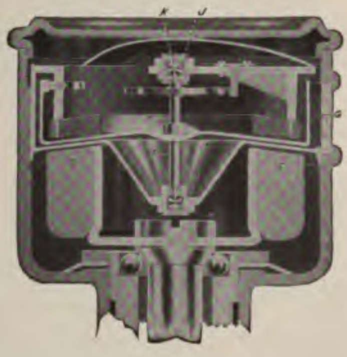
Another type of speed indicator is electrically worked off the front wheel. Mounted on the steering pivot is a small magneto or dynamo driven by a pulley fixed to the road wheel. Wires run from the magneto to a small voltmeter mounted on



Veeder Tachodometer—Form G.



The Warner Auto-Meter.



Sectional View.

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the dashboard. The voltmeter is calibrated in miles per hour, the voltage given by the magneto being proportionate to the speed of the car. That is to say, if the speed of the car is doubled, the output of the dynamo is increased in proportion, the indicator showing the increase in miles per hour.

Speed Limit—The limit of speed set by law for motor vehicles on public highways. It varies in the different states, cities, towns and villages according to local regulations or ordinances, but whatever the legal limit is it is well to be thoroughly acquainted with it and to observe it strictly in order to avoid trouble. In the United Kingdom of Great Britain and Ireland the speed limit is twenty miles an hour, but is restricted in certain districts, local bodies having the power to adopt by-laws limiting the speed within districts over which they have control to any figure which they think advisable, subject to the sanction of the Local Government Board. In such cases they are under obligations to erect signs at the beginning and end of roads which pass through their districts, the sign including a number representing the speed limit in miles per hour. The latter is a provision of British motor car law worthy of wide adoption.

Speedmeter—See Speed Indicator.

Speedometer—See Speed Indicator.

Speed Regulation, Engine—See Governing and Governors.

Speeds, How to Change—See under Driving.

Spelter—The name given to zinc when cast into the ingots of commerce; also an alloy of equal parts of zinc and copper used in soldering, etc.

Spelter, Use of—See under Brazing.

Spider—In machinery, a skeleton of radiating spokes; the internal frame or skeleton of a gear-wheel, for instance, on which a cogged rim may be bolted, shrunk or cast; the solid interior portion of a piston to which the packing is attached and to the axis of which the piston-rod is secured.

A style of light two-seated car with a single detached seat in rear.

[illegible]—[illegible]

[illegible]—[illegible] a [illegible]

[illegible]—[illegible] end of [illegible] another [illegible]

[illegible]—See [illegible] and [illegible]

Spindle—A stationary shaft on which a wheel or pulley is mounted, and on which the latter revolves. The front road wheels of a car are on spindles. Some spindles revolve, such as magneto armature spindles.

Spindle, Armature—See under [illegible]

Spindle Screw—Same as [illegible] Screw.

Spindle Valve—[illegible]

Spinning—The process of shaping metal objects from a disk by means of a spinning-lathe. The disk is fixed to a live spindle and the shape is made by pressing and bending with various tools.

Spiral Gear—See Screw Gear; Skew Gear; Helical Gear; Gear or Gearing.

Spiral Spring—See Springs.

Spirit—A term sometimes used to describe motor car fuel spirit of every description, including gasolene, alcohol, etc.

Spirits, Killed—A solution of zinc chloride, used as a flux in soldering.

Spirits of Salts—Hydrochloric acid.

Spirits, Tin—See Tin Spirits.

Splash-board—A mudguard or protection for the occupants of a car against mud thrown up by the roadwheels.

Splash Lubrication—See under Lubrication and Lubricators.

Splash Lubricator—See Lubricators.

Splice—The junction of two pieces of wood or metal by overlapping and bolting or otherwise fastening the ends; a scarf.

Spline—A rectangular piece or key fitting into a groove in the hub of a wheel and a similar groove in a shaft, so that while the wheel may slide endwise on the shaft, both must revolve together.

Split Pin—A length of D-section wire looped in the center so that the flat sections come in contact with each other and so form a circular pin. It is used to prevent a nut, collar or washer from becoming detached from the end of a bolt. The pin is passed through a slot in the nut, collar or washer, and also a hole in the end of the bolt. The ends of the wire forming the pin are then separated with a screwdriver, which prevents the pin from shifting. See Pins.

Spoke—A spoke is that member of a wheel which takes the whole weight which the wheel is intended to carry. Spokes are of two kinds—tension and compression. Tension spokes are generally made of hard drawn steel wire, held into the hub by means of a head or shoulder, and drawn tight into the rim by a sleeve or nipple. The compression spokes are generally of wood, as in the ordinary car or carriage wheel, but in some cases, as in heavy motor vehicle practice, they are made of wrought iron or even steel tubes. See Wheels.

Spoke Nipple—The nipple or long screwed sleeve by means of which the spokes in wire suspension wheels are fixed and the wheel kept true.

Spoke, Tangent—A metal spoke which forms a tangent with the hub to which it is attached.

Spoke, Tubular—See Spoke above.

Spokes, Broken—See Miscellaneous Roadside Repairs.

Sponge—A porous fibrous substance or organism found adhering to rocks, shells, etc., under water and on rocks about the shore at low tide. In metallurgy, metal in a soft or pasty

[illegible]

[illegible]

[illegible]

[illegible] … [illegible] which is [illegible] revolving part of [illegible] gear. This is a [illegible] better than the "devil," but if carelessly used it is liable to put very severe strains on the transmission gear, especially on the part to which it is fixed. Given good brakes the one great advantage of the sprag is that it permits the car to be restarted on the steepest hill with both brakes off. This saves a lot of racing and possible stopping of the engine.

The older type of sprag consisted of a metal bar pivoted to some part of the frame and long enough to more than reach the ground. It was held up normally by means of a chain or wire, and when let down projected backwards, and thus prevented the car from running backwards. The later form of sprag consists of a pawl which engages with ratchet teeth, cut generally on the frame of the gear shaft or countershaft brake, and which can be let down when necessary. It has the advantage that there is no possibility of the car overrunning the sprag, as sometimes happened with the older arrangement.

Another form of sprag is a wedge-shaped chock or block of wood which can be lowered (by a wire from the driver's seat) so as to stand behind the road-wheels.

Spray Carbureter—See Carbureter.

Spray Deflector—A spraying cone or device to deflect a gasolene spray in a mixing chamber in order that it may mix more thoroughly with the air current.

Sprayer—See Carbureter.

Spray Hood—See under Hood.

Spraying Cone—See Spray Deflector.

Spraying Jet—See Carbureter.

Spraying Nipple—See Carbureter.

Spray Nozzle—The jet of a carbureter.

Springs—A spring may be defined as an elastic substance of any kind having the power of recovering, by its elasticity, its natural state after being bent or otherwise forced—interposed between two objects in order to impart or check motion or permit them to yield relatively to each other. The springs used in a motor car include the carriage springs which diminish concussion between the body and the frame or wheels and the helical or other forms of steel springs used to operate valves, etc.

The Carriage Springs.

As the motor car has developed one of the points in which a great deal of improvement has been made is the carriage springs. With the exception of one or two makes, all the early European cars were fitted with springs that would never have been tolerated on any other kind of vehicle. It was the speed that sold the cars, and comfort became a bit neglected. Now this is being remedied, and springs excelling those used upon carriages are being put in with good results.

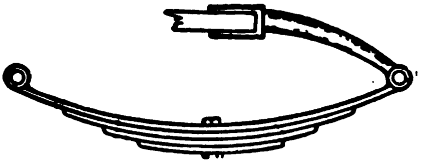


FIG. 1.—HALF ELLIPTIC SPRING.

Modern car springs consist of finely tempered pieces of steel so formed and fastened together that they strengthen each other, while allowing free play for the natural spring of each plate or leaf to act, and by so doing to absorb a large portion of the vibration and jolting caused by the wheels passing over inequalities in the road.

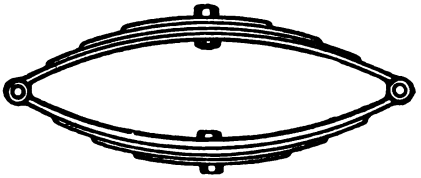


FIG. 2.—ELLIPTIC SPRING.

The springs are mounted between the axles and framework, so that the wheels when passing over an obstruction or sinking into a hollow, compress or expand them, in the first instance, the motion being thus partly absorbed and partly passed on to the frame in a much lessened degree, and with the shock considerably deadened by passing through this elastic medium.

Springs are made in a variety of shapes, with the object of giving greater ease to the occupants of the car, but as the spring motion in a motor car must only be vertical in order not to interfere with the steadiness of the steering the shapes shown are generally used.

Half Elliptic or Semi-elliptic Spring.—In this the C part or dumb-iron attached to the frame takes the place of the upper part of the ellipse.

Elliptic Spring.—The two halves are fastened together with bolts, and the top and the bottom halves attached to the car and axle respectively by bolts or clips in the center.

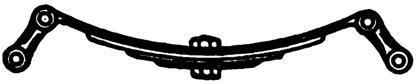


FIG. 3.—GRASSHOPPER SPRING.

Grasshopper Spring.—With linking plates for attaching to shackle.

Volute Spring.—Sometimes used for heavy commercial cars.

Three-Quarter Elliptic Spring.—A similar method of springing to the half elliptic, except that a half spring takes the place of the dumb iron.

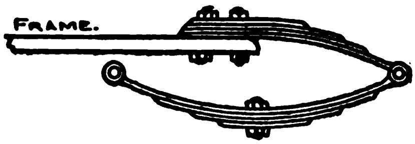


FIG. 4.—THREE-QUARTER ELLIPTIC SPRING.

Among the semi-elliptic springs we may mention the modern style of spring which consists of several leaves, plates or laminations fastened together by clamps or clips. It will be understood that when a spring of this description is compressed the various laminations must slide upon each other. This sliding motion is constantly taking place while the vehicle is traveling. In order to give the leaves the greater ease to slide upon each other it is necessary that they should be lubricated. In some cases grooves are cut along the top faces of the different laminations with slots in each end for the oil to flow between all the laminations.

The top member of the typical spring is of stout spring steel, with lugs forged on each end of it, by means of which it is attached to the shackles. It is furnished with lubricators and slots through which the oil flows to the various grooves.

Only during the last few years has attention been paid to the requirements as to springing of motor cars as compared with other road vehicles. It has been found that the greater loads and the higher speeds make the use of such springs as are usually fitted to slow-moving road vehicles unsuitable for motor vehicle purposes. A comparison of the springs on modern vehicles with those on vehicles made some five or six years ago will show that they have been lengthened very considerably, and that they do not form an arc of so small a circle as used to be adopted; that is to say, they assume a more nearly horizontal position.

The modern half-elliptic is an instance of this altered type of springing. If we can imagine the spring to be considerably lengthened, to have more leaves and to be more widened, and at the same time to be flatter, we shall get an idea as to the direction in which design in springing has been tending. The use of the full elliptic spring has for a long time been almost abandoned, but in several instances it is still used, and when properly designed for motor car purposes, and accompanied with a suitable hanging of the vehicle, it proves very successful. A difficulty about using the full elliptic spring, especially in the case of the rear axle, is the fact that the pull in the case of chain-driven cars, or the torque in the case of gear-driven cars, will tend to cause the axle to move relatively to the frame of the car. In the first instance it is the pull of the chain in transmitting the power which tends to draw the back axle toward the countershaft, while in the case of the gear-driven car it is the fact that there may be no tensional connection between the axle and the car, and therefore driving pressure exerted at the road surface by the wheels will tend to push the axle forward ahead of the car.

This tendency in both cases can be usually prevented, and is so prevented in modern practice, by means of radius rods. These rods tend to locate the axle relatively to the frame, but in the case of a full elliptic spring there is another movement which has to be provided for, that is, the side movement of the springs themselves. This is not very much in the case of springs which are shackled at either end, but where we have a spring as illustrated in Fig. 2, and where connection is made at the top and the bottom only, the radius rods attached to the axle would not prevent the latter from moving sideways relatively to the frame. It is therefore necessary, when these springs are used, to provide some method of staying the body laterally relatively to the axle. In the case of one well-known car, horn plates are used for this purpose, and the axle is prevented from moving laterally relatively to the car frame by means of rollers which come up against the surface of the horn plates.

Another consideration which slightly tends to alter the design of springs is the fact that automobile frames are now built as low as possible. This is not only for the purpose of getting the center of gravity low, but also to allow of very easy and convenient side entrance bodies. If, therefore, full elliptical springs are used, they must be anchored at the top either to brackets which are attached to the frame and which project considerably above it, or else the chassis frame itself must be curved up. In the case of the three-quarter elliptic spring, the top quarter takes the place of the dumb iron (see Dumb Iron), and is generally bolted on the top or on a bracket projecting above the side frame, although it is now becoming more general practice to curve up the back part of the frame so that this quarter of the three-quarter elliptic spring may be bolted directly on it. This curving up of the rear part of the frame also has the effect of giving plenty of room for a big differential gear case on the live axle. In springs which are made up of a few laminations these laminations must necessarily be of substantial thickness to satisfactorily support the load and the shock which comes upon them. If such springs are strengthened as to their power to resist weight and road shocks by increasing the thickness of the metal, their elasticity will be affected. It has, therefore, been found advisable, instead of accomplishing this as in the old method, to increase the width and the length of the different leaves of the spring and to increase their number rather than the thickness of each member. Their elasticity is thus retained, while their capabilities as regards load carrying and shock resisting are also not interfered with.

Shock Absorbers, Anti-Bouncers and Dampers.

The accessories variously called shock-absorbers, anti-bouncers, dampers, etc., are devices designed to check the rapid reaction of a spring which has been suddenly compressed, and thus prevent the bouncing movement of a car, which is induced by the extreme resiliency of modern springs. This reaction causes a bouncing movement, which affects the steering, and by its lifting action tends to temporarily diminish the grip of the driving wheels on the road. It is also calculated to produce side-slip, sets up a violent sway at corners, and causes discomfort to the passengers. The general effect both on the transmission systems and tires is detrimental.

One of the numerous fittings designed to overcome this trouble consists of two arms, one attached to the frame and the other to the spring center. These arms form an L-shaped link connected by a disk. The disk forms a friction grip which tends to make the car spring drag when recovering, so that any violent reaction of the frame is absorbed by the anti-bouncer.

Many other forms of shock absorbers have been put on the market. In some cases they take the form of cylinders and pistons or dash-pots, the gradually increasing resistance to the action of the spring when normally deflected being attained by the displacement of a liquid or air. In other designs they take the form of circular boxes, with oscillating blades moved by the action of the spring. The blade forces the liquid from one compartment to another, the amount of resistance set up being due to the area of the orifice through which the liquid has to pass. Arrangements are generally made for the area of this orifice to be adjusted.

Various Other Springs.

In the internal combustion engine curved springs of finely tempered steel are used in the following places, the size and substance depending on the work to be done: Inlet valves, exhaust valves, governor, clutch, accelerator.

The contact maker, contact breaker, and coil have flat springs—in the first called brushes, and in the latter tremblers.

Helical Spring.—A length of metal of either round or rectangular section wound round an imaginary cylinder. Often miscalled a spiral spring.

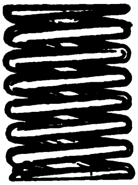


FIG. 7.—HELICAL.

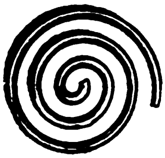


FIG. 8.—SPIRAL.

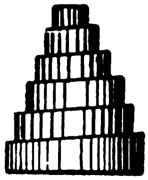


FIG. 9.—VOLUTE.

Spiral Spring.—A length of metal wound in a curve of continually decreasing or increasing radius. The spring when wound is quite flat.

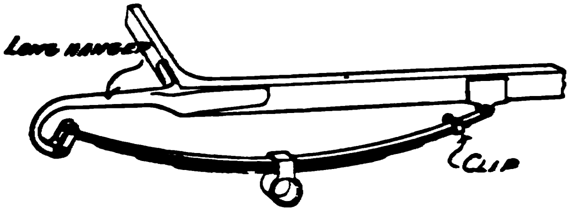
Trembler Spring.—See Trembler.

Volute Spring.—A combination of the helical and the spiral spring.

Valve Spring.—Helical springs or volute springs are used to return the valves to their seatings. These springs, which are of steel, become affected by the heat of the engine after some time, and consequently lose their temper. This leads to sluggish action. See "Valves," in Repairs and Adjustments.

Notes on Carriage Springs.

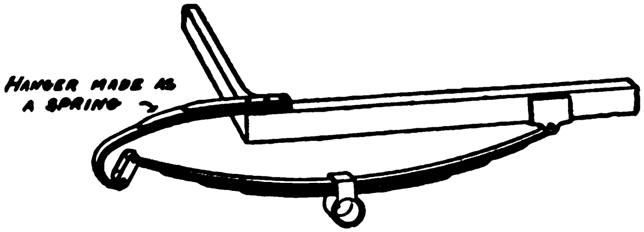
A carriage spring is intended to swallow and conceal the inequalities of the road. It is advantageous that it should rapidly absorb the work done on it while moving rapidly under the force applied to bend it. For this purpose the coach spring is fairly well adapted, as work is done by the friction between the leaves.



Semi-elliptic Spring, showing Toggle Clip and Use of Long Hanger.

From this point of view it is advantageous that the space between the leaves should not be greased, as it is more probable that a spring should break owing to crystallization or other faults than that it should wear out completely by friction between the leaves. The spring that is theoretically required is one which will move quickly when idle or worked on, and slowly when working. It will then be easily displaced by the energy of the shock; but the energy of vibration or displacement which it has stored from the road shock will not be delivered to the car, but wasted by heating the spring.

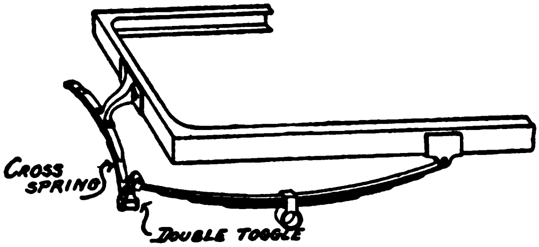
Springs increase the tractive effort to move a body at a given speed on a rough road.



Three-quarter Elliptic Spring, showing Use of Spring Hanger.

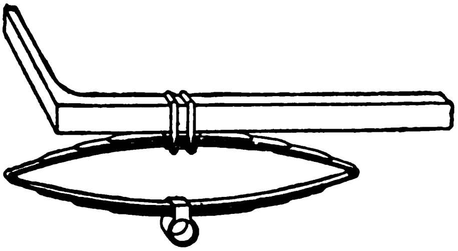
Do not prefer very resilient springs, such as spiral springs, which oscillate much after each road "bump" has passed. This is a proof of a most objectionable quality.

The length of springs is an important factor in the comfort of a car. Extra effective length is secured without lengthening the chassis by making the spring hangers very long, as in one of the illustrations. Another method is to make the hanger itself a spring, as shown. Yet another is to use cross springs at the back of the car, obtaining thus only one point of support. This method, though it introduces a certain amount of swaying of the car, gives additional freedom from shock and relieves the frame of the machine from twisting strains. Double shackles are used in this case.



Semi-elliptic and Cross Springs, showing Double Toggle allowing both springs to expand, also Bracket giving Single Points of Suspension.

A few makers of cars are making the equivalent length of spring greater yet by providing a complete elliptical (some-

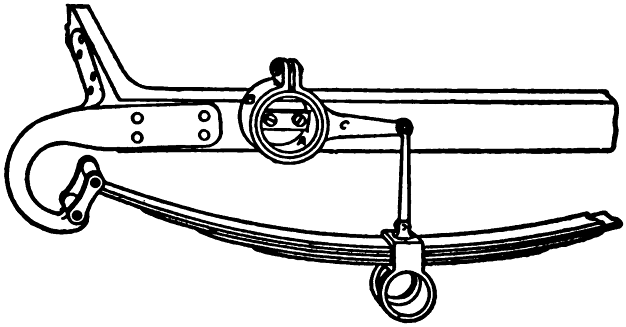


"Double" Elliptic Spring, without Toggle, showing great effective spring length obtained in a short space.

times called a "double" elliptical) spring, as in the figure. This is a reversion to the old practice of several years ago. The mere length of spring is not everything, however, as it is possible for the steel to be too lively, so that the car bounces too much. The springs should be just so soft that they do not subside or become permanently flat or set down with use. All springs settle down a little.

Apart from this, a car must be lightly sprung for comfort, and if lightly sprung to suit the average road and load it will be too lightly sprung for the very worst type of roads. Indeed, it will thump when passing fast over a level crossing, or over those paved and slightly elevated crossings which are a source of damage to every sort of spring vehicle. Rubber buffers may be introduced to diminish the shock, but they are not a cure—only a makeshift.

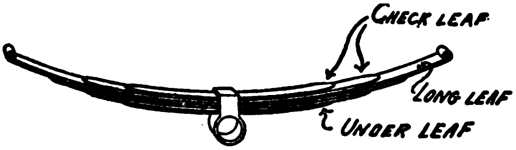
Many ingenious methods of preventing the blow without stiffening the springs or setting them up to a higher curve have been devised. See Shock Absorbers. A simple plan which could easily be home-made by a good mechanic is illustrated. The suggestion was drawn from a sketch in the Autocar, from a Fiat car.



Friction Arrangement to Deaden Too Lively Action of Springs.

The device consists of a small brake drum A fastened on the frame and a brake band B clasped round it and connected by an arm C to the springs, so that whenever they work up and down there is a strong rubbing friction between the brake band and drum, thus retarding and "damping" the oscillations and limiting their amplitude.

Besides introducing friction in the working of the springs, another very cheap and useful improvement may be made to prevent the car bouncing up unduly. This is to clip together the leaves of the springs. It will be noticed that as a rule the top leaf is a long one which receives support from the various short leaves below it in proportion as weight is put on the car. Now in the case of a recoil, when the car body has been shot upwards by the resiliency of the springs, it is only the upper long leaf which is brought into operation to check this travel. Some makers put check leaves (as shown) above the long spring leaf, but the clip is very useful, during the recoil movement of the body, in securing similar results by merely binding the long leaf to the under leaf.



Semi-elliptic Spring, showing method of using extra leaves to check the recoil.

Another device embodies the principles of the Westinghouse buffer spring. It possesses the advantage of exerting no friction when the travel of the springs is small, but much friction or "damping" when the distortion of the springs is considerable, whether up or down.

In this device, the invention of Mr. Krebs, when the arm A of the cam-shaped piece is rotated, the cam head C moves out of the depression D, and the two rings are thereby separated from one another more and more in proportion as the arm A is moved lower. This separation of the parts tends to squeeze together the parts of a minute clutch which are fixed respectively, the one to the car frame by means of the square rod, R, and the other to the movable piece A C. So the degree of the squeezing and hence the friction depends on the shape of the cam and notch. In the present make the clutch is a "plate clutch."

Krebs himself claims that for oscillations exceeding a certain small limit (for which the friction of the springs gives sufficient damping) the device should begin to act, and that the damping or friction produced should be at any instant proportional to the variation in the vertical deflection of the spring. He recommends users to provide the car with springs of greater flexibility than normal when such devices are employed.

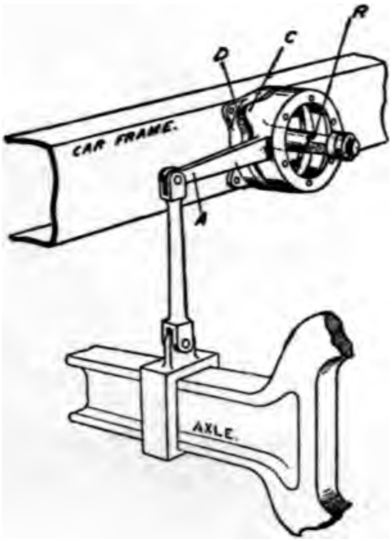


Diagram of Krebs's Damping Device.

When a Spring Leaf Breaks.

The breakage of a spring may be serious or not according to where it occurs and how many leaves are involved. If only one leaf is broken the others probably will carry the load if care is taken not to drive fast over rough spots. The broken leaf, however, must be held in place to act as a spacer for the other leaves. To accomplish this, the whole spring, if the break is in the middle, or half of the spring, if the break is near one end, must be wound tightly with clothesline or some other rope of about that size, Fig. 2. The winding is started at the small end C, Fig. 1, after which the rope is passed once around the spring close to the eye, tied in a single knot, and the short end is led along the top of the spring, where it will be bound tightly by the succeeding turns. The rope should be wound for some distance past the point of the break, and the free end may be fastened either to the spring seat or to the other end of the spring.

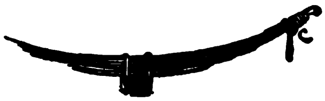


FIG. 1

If two or more leaves are broken at the middle or elsewhere the remaining leaves must be reinforced by a stiff bar of hard wood A, Fig. 2, laid along the top of the spring and bound in place by clothesline in the manner described in the above paragraph. The center of the bar should be over the break, and should be blocked up by suitable pieces of wood B, 3 or 4 inches long so the ends of the bar will have to be sprung downward to bring them in contact with the top leaf of the spring. This puts the bar under some initial tension, and increases its efficiency.

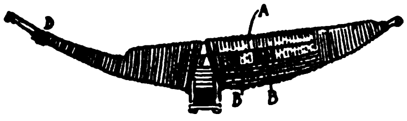


FIG. 2.

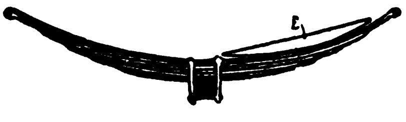


FIG. 3.

In case it is the top leaf of the spring that is broken the bar, such as just described, is necessary even if no other leaf be broken. In this case, however, it will be well for the bar to make contact with the spring leaf all along its length, and for this purpose its under surface D, Fig. 3, may be whittled to a curvature slightly greater than the curvature of the spring. This will produce the initial tension required, by the bar straightening itself to make complete contact with the spring when the clothesline is wound on.

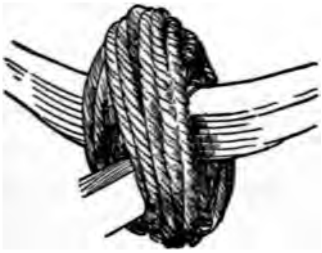


Fig. 4.

As a matter of safety it will be well to improvise a bumper between the spring and frame to prevent the damaged spring from being flexed beyond its safe limit. If a rubber bumper is not available one may be improvised by laying a stick of wood on top of the center of the spring and binding it on with rope wound in as many parallel turns as possible. See Fig. 4. The rope will act as a cushion, and by using a considerable number of turns the shock will not be localized at one point of the frame.—Motor Age.

Spring-block—In a horse-drawn vehicle a piece of wood fixed on the axle as a support for the spring. A distance-piece placed above or below an elliptic spring on a motor car.

Spring Buffer—A shock-absorber. See under Springs.

Spring, C—A carriage spring shaped like the letter C.

Spring, Carriage—One of the springs on which a car body rests and rides.

Spring Clamp—A device for holding a carriage spring on its seat. See Springs.

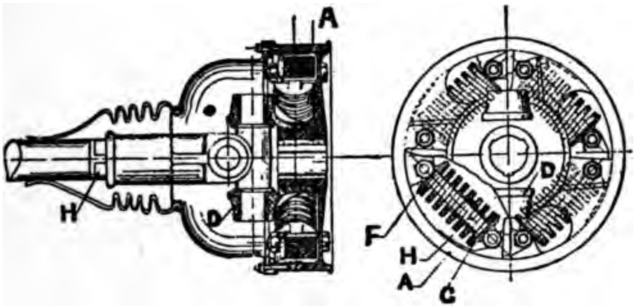
Spring Clip—A device for holding the leaves of a spring together.

Spring, Conical—A coiled spring whose outline resembles that of a cone.

Spring Cotter—See under Cotter.

Spring, Cross, Broken—See Miscellaneous Roadside Repairs.

Spring Drive—In some methods of construction, in order to prevent the harshness which is inseparable from gear drives, a flexible member is interposed in the transmission, generally in the form of a spring or springs, in which case it is known as a spring drive. An instance of this is found in the Metallurgique car. Our illustration shows this arrangement. It is incorporated with the universal joint at the rear of the gear-box, and is arranged inside the brake drum. A is the brake drum, and the springs H are held in position between the two plates G and F. One of these plates is pivoted on the universal joint D and the other on the brake drum. The plates are connected by a pin in one case and a sleeve in the other, the pin sliding in the sleeve. When the power is transmitted from the engine to the brake drum through the gear shaft, the springs H are compressed, the pin and the sleeve causing the springs to compress in the same plane—that is, they are not doubled outward. The drive is then, of course, directly through the springs to the universal joint, and all vibration and grinding in the transmission is obviated, while the whole of the wheels in gear are relieved of a considerable amount of strain and shock.



THE SPRING DRIVE OF THE METALLURGIQUE CAR.

Spring, Elliptic—See Springs above.

Spring, Equalizing—A small spring used as an adjunct to a car spring to equalize the stress of the load, etc.

Spring, Grasshopper—See Springs.

Spring Hangers—The dumb-irons at the end of a car frame, to which the springs are attached.

Spring, Helical—See under Springs above.

Spring-horn—One of the curved parts at the end of a side member of a motor-car frame, to which the springs are attached by means of shackles; a dumb-iron.

Spring Jack—A device for inserting a loop in an electric circuit.

Spring Leaf or Leaves Broken—See Miscellaneous Roadside Repairs; also under Springs.

Spring of a Beam, etc.—The curve of a beam or other member upward from a horizontal line.

Spring Pad—A seat or saddle for a carriage spring.

Spring Pawl—A pawl actuated by a spring.

Spring, Platform—A form of spring used for heavy vehicles. It consists of four semi-elliptical steel springs arranged to form a resilient platform.

Spring, Pneumatic—A device by which air is confined and made to act as a spring by its elasticity; as an air-bag or a cylinder with a close-fitting piston.

Spring, Reach—A longitudinal spring running from the front to the rear axle of a car.

Spring Saddle—The seat of a carriage spring upon an axle.

Spring, Scroll—A spring composed of a flat band or ribbon of metal rolled on itself like a scroll.

Spring Seat—Same as Spring Saddle.

Spring Shackle—A shackle closed by a spring; also a shackle connecting two carriage springs or connecting one such spring to a fixed part of the vehicle.

Spring Shackle Broken—See Miscellaneous Roadside Repairs.

Spring, Spiral—A coiled spring used where the pressure to be resisted is direct and in line with the axis of the spring.

Springs, Examination of—See Overhauling.

Springs, Squeaky—See Squeaky Springs.

Springs, Stiff Valve—See under Loss of Power.

Spring, Valve—A spring by which a valve is opened or closed.

Spring, Volute—A spiral scroll spring.

Spring Washer—See Washers.

Spring Washers, Use of—There are a number of places on a motor car where it is desirable that, while being properly secured, the parts may be capable of being taken down readily. As is well known, the ordinary nut has a great tendency to shake off on the smallest provocation, and possibly allow some part to come adrift when least expected. On the cover of gear boxes, engine crank box covers, and any inspection holes or grease plates, it is necessary, perhaps fortnightly or monthly, to remove these for an inspection of the parts, or for placing therein grease or oil. In such a case the familiar type of split spring washer placed under the nut, which can then be fairly tightly screwed up, is the most satisfactory method, and, furthermore, there are then no small split pins to take out, and on cleaning the car the ends of the split pins are not there to cause scratching of the hands, this being a common experience where split pins are largely used in these places. The usual split pin fitted to the car is often a bad offender in this respect, however carefully turned over and unobtrusive it is made.

Sprocket—One of the toothlike projections on a sprocket-wheel to engage with the links of an open chain, after the manner of gearing. Also used for Sprocket Wheel.

Sprocket Wheel—See Wheels.

Sprue—In casting metal, the ingate through which melted metal is poured into the mold.

Spun Metal—Sheet metal shaped into various forms by means of a lathe. See Spinning. Brass or copper carbureter floats, horns, etc., are so formed.

Spur Gear—Gearing in which spur, toothed or cog wheels are used. See Gear, Spur.

Spur Pinion—A spur wheel.

Spur Wheel—See Wheels.

Squabbing—The upholstery of a car body when it is full or springy is usually finished or covered in leather over horsehair on a spring foundation. The leather is buttoned down in pleats, one button being placed in each corner of the lozenges formed by the pleats. This formation is called the squab or squabbing.

Where there are no springs and where the upholstery work is very much thinner, as on carriage doors and other parts, the leather is often buttoned or stitched down in small lozenge-shaped panels, presenting much the same appearance as the squabbing, but less soft. This is called quilting.

Square—Any squared projection or shank to which other parts of a machine or a tool may be fitted.

Square-headed Bolt—See Bolts and Nuts.

Square Nut—See Bolts and Nuts.

Squeak—A short, sharp, shrill noise made by a wheel, bearing or other part of a machine from lack of lubrication, etc.

Squeaking Noise, A Mysterious—See under Ignition.

Squeaking Noises in Engine—See under Engines.

Squeaky Springs—If your springs squeak distressingly, and their plaint does not cease after a liberal oiling of the suspension joints, there is no cure but to dismount them and introduce a liberal amount of grease between the leaves before assembling and remounting. Before commencing operations, however, the car should be securely supported and blocked up to take all the load off both springs, leaving them in a natural position, so that they can be taken down and put up again without difficulty. When reassembling, put up all pivot bolts with plenty of grease. Fill the holes into which these have to be introduced, and then thrust the eight bolts through. If dismounting the springs is thought to be too strenuous a task, oil can often be sufficiently introduced between the blades in the following manner: Block up the jack securely, so that when at its lowest point it can just be introduced between the blocking and the lower flange of the frame at the rear angle on the side of the spring first to be operated upon. Then screw up the jack until the driving-wheel is raised clear of the ground. This will cause the weight of the wheel and half the axle to depend from the body through the spring, and the leaves will probably separate from each other sufficiently to permit of oil being squirted between them. The effect of the greasing or oiling will greatly add to the docility of the spring, making the car more comfortable, and will certainly cure the squeaking which so keenly annoys the motorist.

The best lubricant for carriage springs is ordinary lead paint or "gray priming" slightly thinned with raw linseed oil, and about 10 per cent of graphite well mixed into the paint. "This lubricant," says a well-known manufacturer, "lasts a great deal longer than motor or axle greases; in fact, it will generally outlast two or three applications of grease."

Stabling a Car on Tour—See Care of a Car on Tour.

Staggered—The term applied to the spokes of a wheel when they are set in zigzag fashion inside or outside of a line drawn around the hub. The objects sought in such construction are increased strength and stiffness of the wheel.

Standpipe—A vertical pipe into which liquid is forced by mechanical means as in a water-cooling or lubrication system.

Standard—A recognized unit of capacity, weight, length, etc. Any form of construction recognized as correct by common consent, by approved custom, or by those most competent to decide; a model, type or pattern.

A post, beam or other rigid upright support for a piece of machinery, etc.

Standard Equipment—See under Equipment.

Stands—Devices by which a motorcycle may be kept in a vertical position while at rest.

Stanhope—Originally a light two-wheeled horse-drawn carriage without a top, so called from the gentleman for whom it was contrived. A similar four-wheeled vehicle or a motor car of like body construction—single seated with high panels. The latter is sometimes fitted with a top, as in the case of electric stanhopes.

Star Coupling—The name given to an elementary form of toothed clutch used to connect the road wheel with the driving axle in live axle driven cars.

This form of coupling is associated with an excellent modern method of driving the road wheels. See Wheels.

Starting—This subject is fully dealt with under Driving.

Starboard—The right-hand side of a ship or boat when one stands looking toward the bow.

Starters, Automatic—Various devices are used to secure the starting of internal combustion engines without the necessity of having recourse to a cranking handle. These operate on various principles, some by means of a coiled spring, the release of which turns the crankshaft and thus replaces the starting handle; others by storing up mixture under compression in a special receptacle fitted to the car, to be released by a valve operated from the dashboard when required. Still others revolve the crank shaft by means of a cylinder, piston and rack, or pump air and vapor into a mixing chamber or tank from which the mixture can be admitted to the cylinder heads when required to start the engine. See Starting Gear.

Starting an Engine Easily—See under Driving.

Starting-bar—A hand-lever for operating the valves so as to start a steam engine.

Starting by Handle, Easy—See Easy Starting, etc.

Starting Crank—The handle by which the crankshaft of a motor can be turned in starting.

Starting Gear—The means provided for starting the engine of an automobile usually consists of a crank handle of suitable length placed in front of and below the radiator, in the case at least of vertical engines. The boss of the handle fits on to the end of the motor shaft or a shaft geared to it, and has inclined teeth to engage corresponding teeth or a cross pin on the shaft. This inclination of the teeth is such as to release the handle when the motor begins to drive, so that the operator may not be struck by it. Sometimes the handle is detachable altogether—in which case it is liable to be lost; in most makes, a stop prevents the handle coming right off, and so it is always ready for use.

It is very important that the ignition should be well retarded before attempting to start the motor, as, if too far advanced, the motor is very likely to begin driving the wrong way, and as the handle does not release under these circumstances, a severely strained or broken wrist is a probable result. A few cars are so arranged that the starting handle cannot be pushed home unless the ignition is retarded. It is more common, however, to provide means (sometimes operated by the mere pushing of the handle into engagement) for releasing the compression somewhat during starting operations. It is no joke to try to force a big motor through a full compression stroke by hand.

With a four-cylinder motor the chances are that it will stop with one or other of the cylinders ready to fire, so that such an engine can often be started by merely switching on the current, after retarding the ignition. Some makers now provide means for starting the motor from the driver's seat, and we expect to see this practice extended, although such a fitting tends to a little further complication.

There are various ways in which the idea can be carried out. According to one method a separate carbureting device is employed; the waste gases are pumped out of the cylinders and charges of fresh gas are pumped in. The current is then switched on to produce a spark in the cylinder which happens to have its piston in the right position, and the engine starts. Another way is to cause the motor to pump air into a reservoir just before stopping, and then to employ the compressed air to operate the motor on restarting. Or a spring may be used in a somewhat similar way, the spring being first wound up by the motor, which is afterwards restarted by the reaction of the spring. One of the simplest ways is to fit a "free wheel" clutch on the engine and wind a cord to a lever near the driver's seat, so that he can pull the cord and start the motor without getting down.

Starting, Difficulty in—See under Difficulty.

Starting Engine in Cold Weather—See Cold Weather.

Starting Handle—The crank or handle fitted for starting the engine. It has to be provided with some sort of clutch so that the engine crank shaft can overrun the handle to prevent injury to the person running it.

Starting Handle Repair—See Makeshifts on Tour.

Starting Lever—See Levers.

Starting Motor on Coal Gas—See under Driving.

Starting of Engine, Easy—See under Driving, Easy Starting, etc.

Starting on Spark—See Starting Gear.

Starting Single-Cylinder Engines—See under Driving.

Starting Steam Car—See Steam Car, under Motor Car.

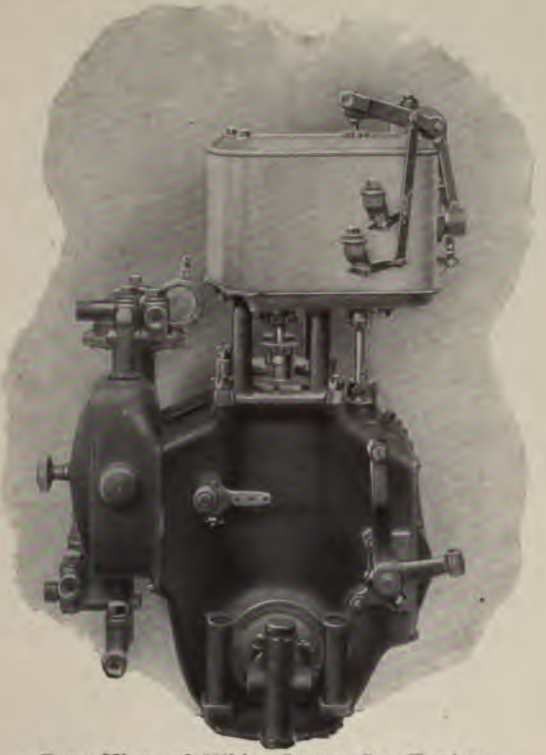
Starting the Engine—See under Driving.

Star Wheel—A disk or wheel having V-shaped teeth with an angle of 60 degrees; used chiefly in clock register or indicator mechanisms, as in speed indicators, etc.

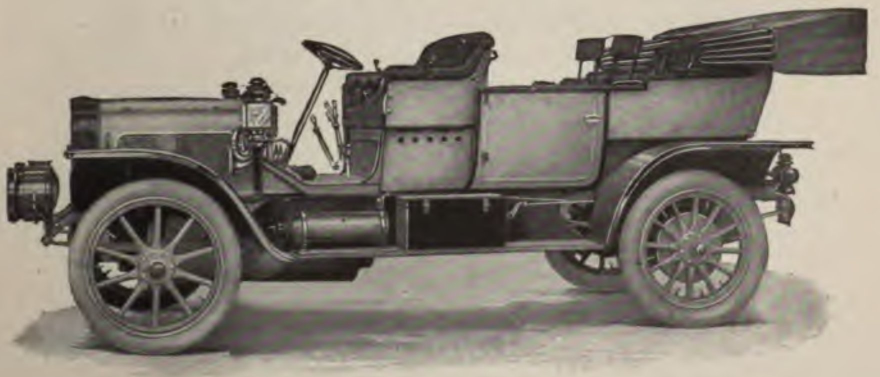
Stationary Rear Axle—See under Axle.

Stay—A term applied to any member of a machine or other structure which is used to fix the position of two parts in relation to each other. It is generally applied in the form of a tie rod, but sometimes may take the form of a compression rod or strut. The tension rod which runs from either side of a live axle and supports the under side of the differential box is an example of the stay. Stays, also known as wing irons, are used to support side wings or mudguards on a motor car.

Stay-bolt—A bolt or rod binding together opposite plates.



Rear View of White Steam Car Engine.



Model "M" 40 Horse-Power White Steam Touring Car.

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OF

Steam—The vapor given off by water after it has reached the boiling point.

Exhaust Steam.—The steam which is given off out of the cylinders of a steam engine. It can be ejected into the open air, but in the case of motor cars it is more often passed through a condenser, in which it is condensed back to water, and is used over again in the boiler.

High Pressure Steam.—A relative term in steam engine practice. It indicates very high pressure as distinct from low pressure. Five hundred pounds to the square inch would be considered high pressure steam.

Low Pressure Steam.—Used in contradistinction to high pressure steam.

Saturated Steam.—Steam which carries over with it moisture in suspension. It is the object of steam engineers to increase the steam pressure and temperature to such an extent as to practically dry the steam. For this purpose superheaters are used in steam car engines, the steam passing through the superheaters in order to dry it. It is of the utmost importance that in small fast-running engines the steam should be dry, otherwise condensation takes place, and damage to the piston and cylinders will ensue, owing to water collecting in the piston heads. See Superheater.

Superheated Steam.—Steam which has been passed through a superheater.

Steam Boiler—A vessel in which steam is generated for conversion into power. It is specially constructed to hold and sustain an internal pressure. Tubes or flues are used in boilers to increase the heating surface and boilers fall into two main groups—fire tubular boilers and water tubular boilers. In the first kind the tubes are traversed by the heat and in the second by the water.

Steam Car—See under Motor Car.

Steam Cars—In the early part of the nineteenth century numerous and partially successful attempts were made to build and operate self-propelled vehicles. In several cases such vehicles ran regularly with passengers as common carriers between English towns. These pioneer automobiles were all steam-propelled, and if the vicious legislation that killed the movement in those days had not come about, it is possible that the steam engine would have been brought to such a state of perfection for road use that the internal combustion engine would never have had a chance. As matters stand, however, we find that the makers of steamers have approximated their designs to those of gasolene cars, and that even the slide valve shows a disposition to retire in favor of the mushroom type.

In principle the steam engine is at a disadvantage in comparison with the gasolene motor, in that an additional process is passed through in converting the fuel into motion. Thus:

Gasolene motor—Fuel, combustion, motion.

Steam engine—Fuel, combustion, generation of steam, motion.

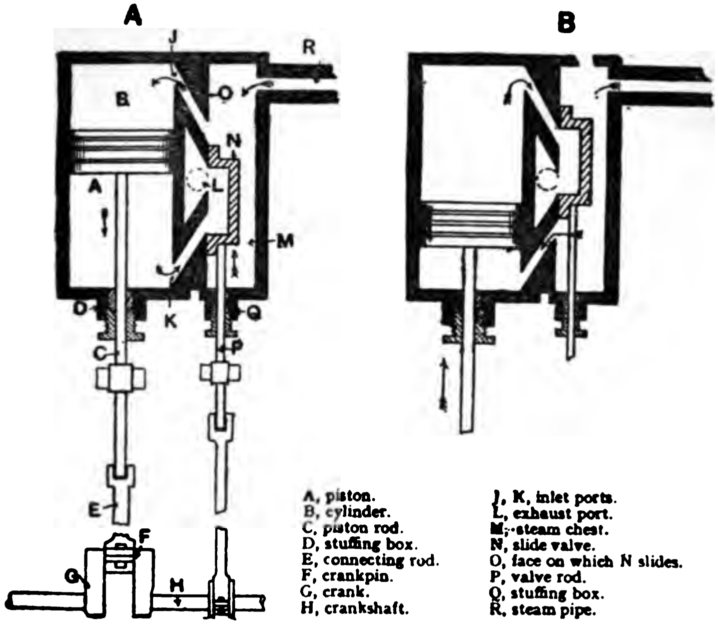
And, unfortunately for steam, the extra step always involves the expenditure of a large quantity of fuel. Further, the steam generator occupies a lot of space, though its reputation for being dangerous has no foundation in fact.

On the other hand, if an ordinary double-acting two-cylinder steam engine be employed, the flywheel, clutch and change speed gear may be dispensed with. The engine gives two impulses per revolution for each cylinder (four times as many as the single cylinder gasolene motor). It starts and stops with the car (which has both advantages and disadvantages) and can be used as a brake. The great flexibility of the steam engine enables the power to be adjusted to the "load," instead of the load having to be adjusted to the power, as on gasolene car.

Steam Engine Systems.

The modern automobilist has been so much more brought into contact with the internal combustion system that his education, from the steam point of view, has been neglected, and it may be as well to review the latter system briefly.

When water is raised to a temperature of over 212 degrees Fahr. it becomes converted into steam; and the useful quality of steam is its expansiveness. The water is "vaporized" in a boiler heated by a burner or furnace, and the steam is led through a pipe to a cylinder containing a piston. On the steam being admitted to one end of the cylinder it drives the piston toward the other end. The lineal movement of the piston is converted into a rotary movement of a shaft by means of a connecting rod and crank. A single-acting, single-cylinder engine such as that so far described, would require a flywheel to effect the return stroke of the piston. In practice, either the number of cylinders is increased or a slide valve is employed to admit the steam to each end of a single cylinder alternately. Sometimes after the steam has partly expanded in one cylinder, it is led into a second where it further expands. These cylinders are called the "high-pressure" and the "low-



A, piston.
B, cylinder.
C, piston rod.
D, stuffing box.
E, connecting rod.
F, crankpin.
G, crank.
H, crankshaft.
J, K, inlet ports.
L, exhaust port.
M, steam chest.
N, slide valve.
O, face on which N slides.
P, valve rod.
Q, stuffing box.
R, steam pipe.

Figs. A and B—Section through Cylinder and Slide Valve. A, Outward Stroke; B, Return Stroke.

pressure" respectively, and the engine is said to be a compound one.

Action of Slide Valve.

The action of the slide valve may be readily understood, references being made to Figs. A and B. The piston A moves to and fro in the cylinder B. The piston is fixed to a piston rod C, which passes through an aperture in one end of the cylinder by means of a steam-tight gland and stuffing-box D. A second rod E connects the outer end of the rod C with the crank pin F of the crank G on the crankshaft H. These two rods are necessary, because C must be confined to a straight line in order to secure a steam-tight joint at D, while the jointing of E allows for the divergence of the crank pin F from such straight line. The outer end of C travels in suitable guides. In one wall of the cylinder are three ports or passages—J, K and L—the first two of which open into the steam chest M. The other ends of the ports J and K open into the respective ends of the cylinder. The port L is for the exhaust; it only communicates with the cylinder indirectly, and is never open to the steam chest M.

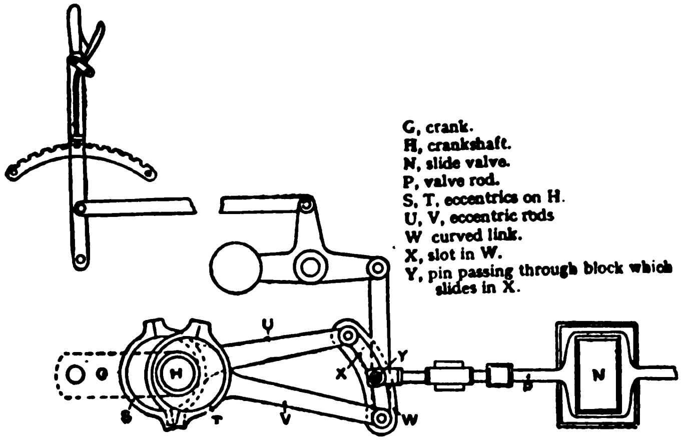
Over the ports J, K, L, slides a valve N, having a recess in its face and projecting ends. It is called a D valve, from the shape of its longitudinal section. The valve N is moved, in close contact with the face O, by the rod P, which passes through the stuffing-box Q, and is operated by the shaft H through an eccentric motion.

The action is as follows: Supposing the piston A is near the top of the cylinder B, and the port J is uncovered. Steam will then be free to pass from the boiler through the pipe R into the chest M, and thence through the port J into the upper part of the cylinder. Here the expansive force of the steam presses on the top of the piston and drives it downward. As the piston A descends, the shaft H rotates and drives up the valve N, the upper lip of which gradually passes over the end of the port J until the steam is finally cut off. The steam, still expanding, continues to force the piston downward to the end of its stroke. Soon after the piston has begun its return stroke the valve N reaches such a height that it has begun to put the port J in communication with the exhaust port L by means of the recess, and the steam above the cylinder begins to return through the port J and escapes through the port L. The further upward movement of the valve uncovers the port K and admits steam through it to the part of the cylinder below the piston, which is consequently driven up. While the piston is rising, the valve reaches its highest point and begins to descend, so that first the port K is closed (cutting off the steam), and then, almost directly after, the port J is closed (cutting off the exhaust). The result is that a small quantity of steam is imprisoned in the cylinder above the piston.

Thus, at each stroke of the piston, whether outward or return, we have, on each side of the piston alternately, first, admission of fresh steam, cut off and expansion of same, and lastly, exhaust of all but a residue. This residue helps to maintain the heat of the cylinders, and so prevents condensation of the steam next admitted.

Stephenson Link Motion.

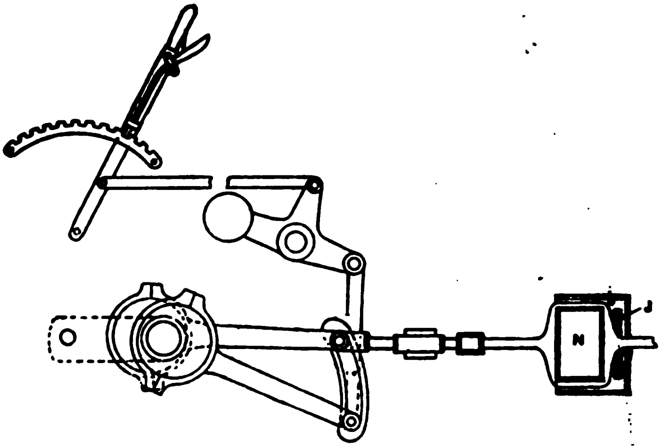
The slide valve lends itself to the production of two important modifications from the action just described. By altering



G, crank.
H, crankshaft.
N, slide valve.
P, valve rod.
S, T, eccentrics on H.
U, V, eccentric rods
W curved link.
X, slot in W.
Y, pin passing through block which slides in X.

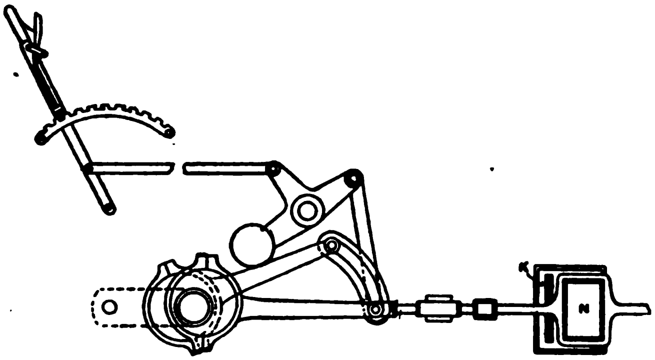
STEPHENSON LINK MOTION.—NEUTRAL POSITION.

the stroke or travel of the valve, the admission of steam to the cylinder can be cut off sooner or later, and the power decreased or increased accordingly. And by altering the timing of the valve relatively to the piston, the direction of rotation of the crankshaft can be reversed. These two modifications are, as a rule, both attained by the employment of a single mechanism known as the Stephenson link motion, having been introduced by the eminent steam engineer of that name. The mechanism comprises two eccentrics S and T, fixed to the shaft H in such positions relatively to the crank G as to be suitable, one for actuating the valve for forward driving, and the other for reversing. Each eccentric is embraced by a "strap," and from these straps proceed rods U and V. But the rods, instead of being jointed directly to the valve rod P, are connected to the ends of a link W, which has a curved slot X. The end of the valve rod P carries a pin Y passing through



Stephenson Link Motion.—Forward Position.

the slot X in which a block can slide. Means are provided for moving the link W relatively to the pin Y. When the link is moved to one extreme position, the rod U is brought opposite the valve rod P, and the valve is operated by the eccentric S, while the other end of the link is oscillated by the eccentric T by the rod V; but the oscillations are quite, or so nearly, concentric with the pin Y that they have no disturbing effect upon the action of the slide valve. In order to reverse the engine, the link W is moved to its other extreme position, so as to bring the rod V more or less opposite the rod P, when the valve will be operated by the eccentric T; the action of the eccentric S being in turn rendered ineffective by the oscillations of the link.



Stephenson Link Motion. Reverse Position.

So much for the reversing. As to the variable cut off, it will be obvious that in moving the link W away from either extreme position, the motion of the pin Y, and hence of the rod P and valve N, will be gradually reduced; and the opening of the ports J and K will be similarly reduced, the steam being cut off earlier and earlier. This is called "notching up," a rack being provided for retaining the link in any position at which it may be set. At the middle position of the link W no motion is transmitted to the valve-rod P.

Function of Right-angled Cranks.

As the engine is not started by setting it in motion by a handle, as with a gasolene motor, but by admitting steam to the cylinder, some difficulty would be encountered if the piston happened to be at either end of its stroke at the moment; as the crank G then being in line with the rods C and E, the shaft H would have no more reason for turning in one direction than in the other, and things would be at a standstill. The use of the second cylinder enables this difficulty to be overcome by setting its crank at right angles to the crank of the first cylinder, so that when one crank is at "the dead point," the other is in its most effective position. This also contributes to smoothness in working after the car has started, the average "torque" or turning effort on the crankshaft being but little departed from at any point of its revolution.

That is about as far as it is advisable to go in general principles of the steam engine for our present purpose, for while practically all the gasolene cars use motors working on the four stroke or Otto cycle, described elsewhere in this work, some of the most important steam cars differ essentially in their engines from the orthodox lines we have sketched.

The Turner-Miesse.

Among European steam cars, the Turner-Miesse is the only well known steamer of British manufacture. The generator consists of a series of tubular sections placed one above another, and connected by U tubes arranged externally of the generator casing. The burner is of the atmospheric type, as usual, and consumes good quality kerosene. The generator and burner are mounted in front of the car under the bonnet. Steam is led to a three-cylinder, single-acting engine, which drives a countershaft through spur wheels. The countershaft is balance geared, and is connected up to the driving road wheels by side chains, as in the chain system of driving gear described elsewhere in the Cyclopedia. The pump maintaining the pressure on the fuel tank works automatically, but otherwise the control is all positive. Hand and steam pumps are fitted for delivering water from the tank to the generator, via a feed water heater. The cut-off and reverse, and the quantity of water supplied to the generator, are regulated by conveniently arranged handles below and above the steering wheel respectively. The latest models are improved in detail and have live axle drive.

The Gardner-Serpollet.

The Gardner-Serpollet formed another distinct type of steam car. While it was frequently altered, the changes were almost always improvements, and showed the continued ingenuity of its clever French inventor. To begin with the boiler—there is none, in the proper sense of the word. Instead of heating a volume of water, small quantities are pumped rapidly into a series of very hot tubes bent in parallel formation. These tubes are of heavy gauge, and are stacked in horizontal layers in such a way that as much tube as possible is exposed to the direct action of the furnace. The result is that the installments of water are "flashed" into steam as they enter the generator, and the steam leaves it perfectly dry and highly superheated. The furnace consists of a kerosene burner that has been brought to a high state of perfection. With the aid of the condenser the water which can be carried will last for a run of any ordinary length, and provision is made for carrying a corresponding quantity of kerosene. The water and oil are fed in due proportion by a donkey pump which is brought into action automatically when the steam falls below a certain pressure. As soon as the pressure is restored, the "donkey" ceases working. The exhaust from the donkey engine is used to increase the draught through the burner.

The Serpollet engine comprises either two double-acting or four single-acting horizontal cylinders. They have mushroom admission and exhaust valves, like an internal combustion motor. The engine is regulated by varying the lift of the admission valves and hence the cut off; and the gearing actuating these also provides for reversing. More or less steam is obtained by regulating the donkey pumps. Power is transmitted from the engine to the live axle by a universal shaft. The wheels, frame, and bodywork are all substantial.

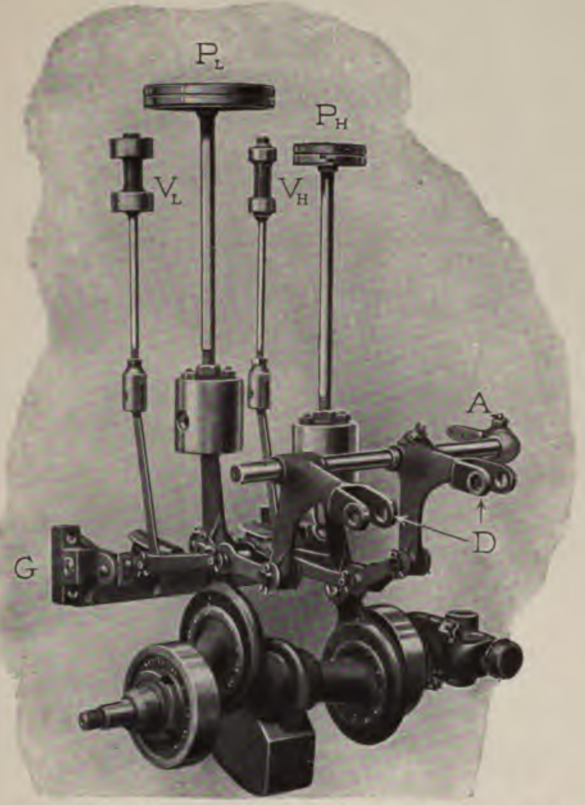
The White Steam Car.

The representative American steam car is the White, well known on both sides of the Atlantic.

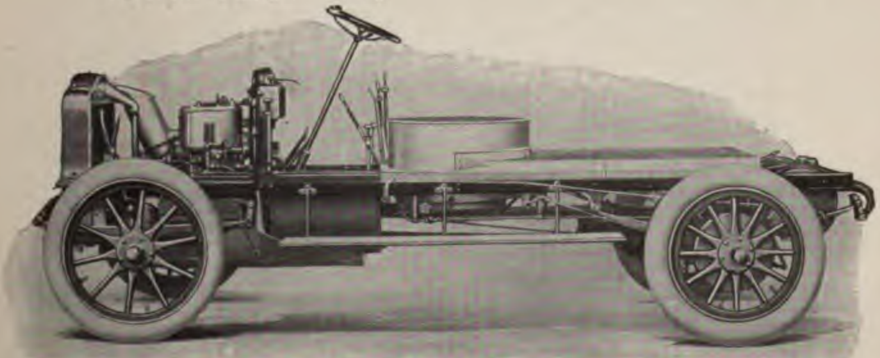
So far as its general appearance goes, the White might easily be mistaken for a gasolene car, though it has several characteristic features. The steam generator consists of a cylindrical stack of coiled tubes. The ends of the coils are led up to, and are connected at, the top of the generator, where the water is admitted. The water becomes converted into steam at some point about half way down the coils, and the steam issues from the bottom of the generator superheated some one hundred and fifty degrees. The lower coils are constructed to stand this heat as their normal condition, and there need be no fear of explosions. As the ends of the coils are taken to the top, the water cannot run down through the generator by gravity—it has to be forced down by the pump. There is, therefore, no water level to maintain, rather the reverse. There are two steam pumps and one hand pump for supplying the water to the generator. Only one steam pump need be used as a rule, but the second comes in handy for hill-climbing. The fuel is gasolene. The working steam pressure is about 450 pounds per square inch, and is maintained automatically. The water pressure from the pump acts upon the fuel supply through a needle valve, so that the greater the quantity of water pumped, the greater the heat provided to vaporize it. The varying heat of the steam operates a thermostat which regulates both the water and fuel supplies in such a way that, as the temperature rises, more water is admitted to the generator, the overheating of which is thereby avoided.

Distinctive Features of the White.

The engine has two vertical cylinders, and though these can be used independently in an emergency, they normally act compound, the steam first partly expanding in the small high-pressure cylinder, and then being led into the larger low-pressure cylinder, where it further expands. The slide valves and link motion in the earlier models are on the accepted lines described in the introduction to this article. The crankshaft is mounted in ball bearings. The engine is furnished with a



The Working Parts of the White Steam Engine.
P—High-pressure Piston (H); P—Low-pressure Piston (L); V—High-pressure Valve (H); V—Low-pressure Valve (L); G—Valve Guide, by tilting which the Engine is reversed; A—Rocker-arm which drives the oiler; D—Rocker-arms which drive the Pumps.



The White Steam Car Chassis.

flywheel and with a crank-case to obtain splash lubrication. Further, the universal shaft is accompanied by a two-speed gear. The drive is direct on the top speed, and indirect on the low speed, or "emergency gear" as the makers call it. The change of speed necessarily involves a free or "out of gear" position, and this allows the engine to drive the pumps while the car is at rest, so that if the steam has been allowed to get very low, it can be worked up quickly without using the hand pump. The latest White steamers represent a general all-round improvement on the earlier models without departing radically from the principles of the latter.

The Latest White Steamers.

"Unusual interest centers each season in the plans of The White Company," says a writer in The Automobile, "because the White Steamer is the distinctively American machine and the annual announcements dealing with the development of its characteristic features are something more than echoes of the doings of Italian, French or German designers. Furthermore, the announcements of The White Company are of interest not only to the automobile public, but also to engineers all over the world, because the power plant of the White car is known to them as the most economical and efficient steam power plant ever devised, and the White generator as being radically unlike any other type of steam-making device."

Because of this very general interest in the developments of the White design, we reproduce below a description of the latest model 40 H. P. and 20 H. P. White steam cars. These two models, while differing from each other widely in power, in size and in price, resemble each other in their general lines of construction. The horse-power ratings of the two models are based on the actual power delivered at the rear wheels, not merely on formulas nor on the power delivered at the engine.

"The larger of the new White cars is rated at 40 steam horse-power. The wheel-base is 122 inches; the front tires, 36x4 inches and the rear tires 36x5 inches. The car is regularly fitted with a straight-line seven-passenger body. The engine is compound, of new design, described in full below. The high pressure cylinder is of 3 inch bore; the low pressure cylinder of 5 inch bore, and the stroke is 4½ inches. The frame is of armored wood, the reinforcing plates of nickel steel being fastened on both sides of the wooden sills. The front axle is of the tubular type; the front springs are 44 inches long and 2½ inches wide; the rear spring 55 inches long and 2½ inches wide. Both the foot-brake and the hand-brake act on drums on the rear wheels, the former being of the expanding type and the latter of the contracting type.

"The smaller of the new White cars may be described more appropriately as a smaller edition of the new 40 H. P. car, rather than as a successor of any previous model. It is rated at 20 steam horse-power. The wheel-base is 104 inches and the tires, both front and rear, are 32x3½ inches. The car is regularly fitted with a straight-line five-passenger body. The engine, except as regards size, is identical with that in the larger car. The high pressure cylinder is of 2½ inch bore, the low pressure of 4¼ inch bore; the stroke is 3 inches. The frame is of heat-treated pressed steel. The front axle is a one-piece forging of I-beam cross section. The front springs are 37 inches long and 1¾ inches wide; the rear springs are 45 inches long and 1¾ inches wide. Both the foot-brake and the hand-brake act on drums on the rear wheels, the former being of the expanding type and the latter of the contracting type. As in the 40 H. P. model, the water tank is placed under the footboards and the fuel tank is in the rear.

"The principal mechanical change in the new cars, as compared with previous White models, is in the engine. As previously mentioned, the engines in the two new models differ only as regards dimensions and, therefore, the following description applies to both models: The new engine construction has been undergoing a thorough trying-out for two years, and both the engines have been subjected to tests of over 30,000 miles of usage and, therefore, may be regarded as thoroughly seasoned products. The change in the engine may be summarized as follows: in the place of one standard type of valve mechanism, another standard type of valve mechanism is used. In former years, the engines used in the White cars were fitted with the Stephenson valve motion, which was actuated by eccentrics on the crankshaft, as were also the pumps. The new White engines are fitted with the Joy valve motion, which is actuated directly from the connecting-rods; and the pumps, all of which are located on the left-hand side of the engine, are driven by the levers of the valve mechanism.

"This new construction permits of a great simplification of the engine. The number of parts is reduced almost to a half of those formerly necessary, considerable weight is saved, all eccentrics are done away with and the cylinders are brought close together, permitting the use of a short one-piece crankshaft and the new shaft is a one-piece forging of tool steel. There are but two main bearings to the crankshaft. They are of the annular type and may be removed from the crankshaft by taking off the lock nuts and lock washers. The two main bearings and the two connecting-rod bearings are fitted with ball separators and the balls are of extra large size. The connecting-rods are one-piece forgings.

"The working parts of the new White engine include the pistons, cross-heads, connecting rods, crank, valve mechanism and pump levers. Both the high-pressure valve and the low-pressure valve are piston valves. Steam is admitted through the center of the valves and exhausts at the ends. The pressure on the valve stuffing-boxes is thus reduced to that of the exhaust from the respective cylinders. A small arm on the end of the pump rocker-shaft is connected by means of a rod to a ratchet device which drives the oiler placed on the dashboard. The sprocket on the forward end of the crankshaft is connected by chain to the fanshaft and the ratio of the sprockets is such that the fanshaft runs faster than the engine. The fanshaft housing is held in place by eccentrics and the tension of the chain may be readily altered by turning these eccentrics. As a good draft of air between the condenser tubes is an important element in securing good condensation, which means good economy in water consumption, these improvements in driving the fan are of no little importance.

"The crank-case of the engine is made in one piece, but ready access may be had to all the parts within by the removal of the side and bottom plates, and the crankshaft may be taken out through either end. The new engine permits of a pleasing and symmetrical arrangement of the necessary piping and everything under the bonnet is easily accessible. Stuffing-boxes are fitted to the upper end of the slides in which the cross-heads travel, so that no oil may be splattered out of the crank-case. The pumps are entirely inclosed so that they may be kept free from dust, yet they are readily accessible. There are the most thorough provisions for keeping the pumps and all parts within the crank-case well lubricated.

"The cylinders are provided with relief valves for getting rid of any water which may be in the cylinders when starting the engine cold. These valves are opened momentarily by a little lever on the dash, before admitting steam to the engine, and the entering steam quickly and effectually removes the water.

"The engine is so adjusted that it runs normally on cut-off—that is, the admission of the steam to each cylinder is stopped before the end of the stroke and the steam then works expansively for the balance of the stroke. In starting the engine, the pushing of the simpling pedal allows the engine to take steam during the full stroke. There is also a cut-off pedal which, when pressed, produces the same result. This cut-off pedal is used only when slow, hard pulling is required, as in climbing particularly steep grades or running over very heavy roads. An interesting feature of the Joy valve mechanism is that, when the cut-off is changed, the lead of the valves is unchanged and the engine thus runs more smoothly on cut-off than was possible with the Stephenson valves. The engine is reversed and the cut-off is changed by simply changing the tilt of the valve guide.

"The engine is supported on two cross-members of the frame which are so placed that the entire weight of the engine is behind the front axle. It is so hung that the driving shaft is perfectly horizontal and, as there is neither clutch nor transmission gear on the White, the drive is direct and positive from the engine through the driving shaft to the rear axle.

"The exhaust pipe from the engine to the condenser is located on the right-hand side. Within this exhaust pipe there is a coil of piping, through which the water from the pumps circulates on its way to the generator. This arrangement thus constitutes a neat and compact feed-water heater which performs the double function of heating the feed-water and of aiding the process of condensation.

"The generator is of the same construction as in former years. For those who are not familiar with this device, it may be said that the White generator consists simply of a series of coils of steel tubing, placed one above the other, and connected in series. If the whole were to be unwound and straightened out, the generator would be seen to be made of a single long piece of tubing. In operation, water is pumped into the upper coil and steam issues from the lower coil. There is but a very small quantity of water and steam in the generator at any given moment (in the larger car the total capacity of the generator is less than one-third of a cubic foot), but the process of making steam is so rapid that steam is always available in the quantity which the running conditions may make necessary. In the new cars, the generator tubing is of one-half inch internal diameter but the length of tubing used differs, of course, for the two models.

"The strength of the tubing used in the White generator is greater than can be definitely determined by any available testing apparatus. Professor R. C. Carpenter, working in the laboratories of Cornell University, found that the tubing withstood a pressure of 18,900 pounds per square inch without showing any signs of rupture. The tests could not be continued with higher pressures owing to the limitations of the testing apparatus. It should be thoroughly understood, however, that the safety of the White generator does not depend upon the integrity of the tubing. In other words, if the tubing

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[illegible]

[illegible]

[illegible] would result

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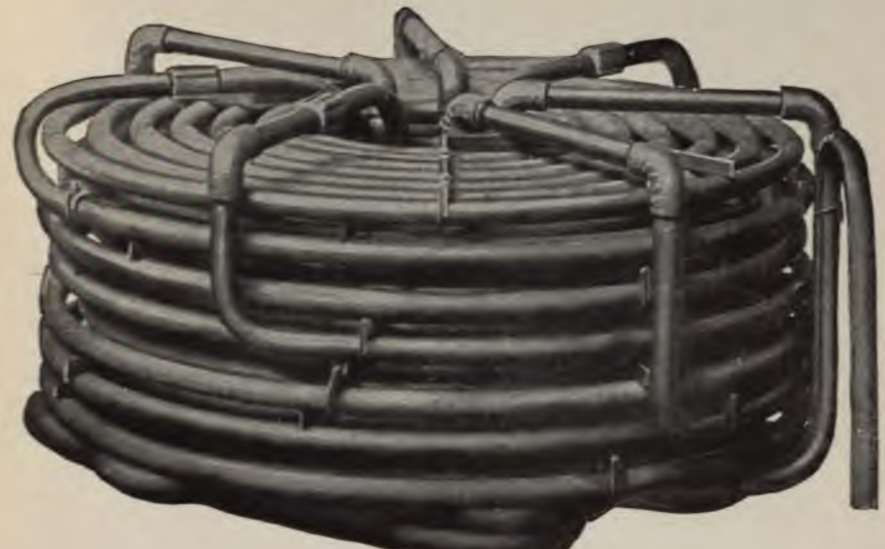
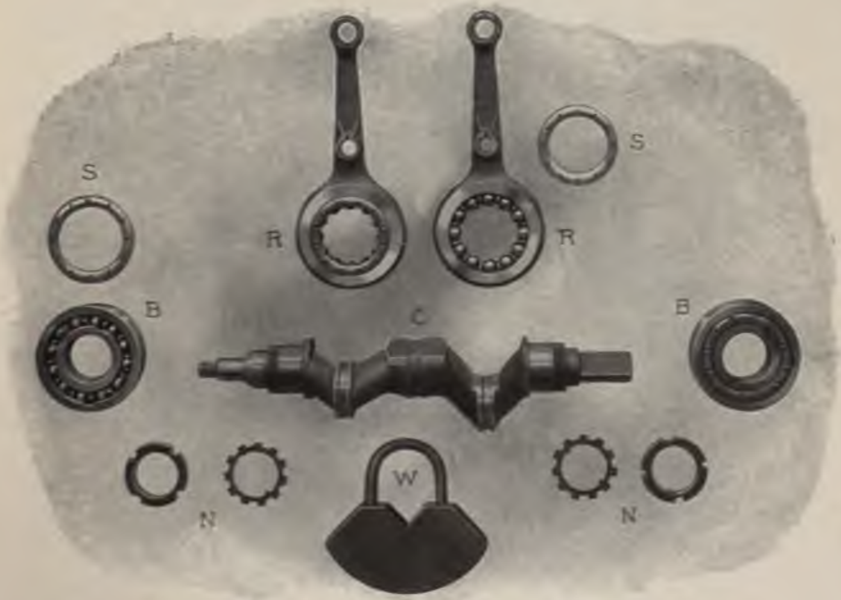


The White Steam Generator.



Crankshaft and Parts—The White Steam Engine.

C—Crankshaft; B, B—Crankshaft Bearings; N—Lock Nuts and Washers; W—Counterweight; R, R—Connecting Rods with Ball-bearings in place; S, S—Ball Retainers.

of those built several years ago, yet it is a singular fact that some people entertain a prejudice against the White of today, based solely on a dislike or suspicion of some makes of steam cars built years ago by incompetent people.

"The illustration shows diagrammatically the circulation of the water and steam through the generator. It will be seen that the water or steam, in order to pass from one coil to that next below, must be forced up to a level above the top coil and must then pass down again. This feature is an important element in the construction of the generator, as it prevents water from descending by gravity and renders the circulation down through the generator dependent upon the action of the pumps.

"The system of regulation, whereby the temperature and pressure of the steam are kept constant without in any way engaging or requiring the attention of the operator, is the same in the new models as in the 1908 machines. To describe briefly the scheme of regulating, the supply of water to the generator and the supply of fuel to the burner are so controlled as always to be in perfect balance with each other. As soon as the steam pressure rises appreciably above the normal working pressure, both supplies are at once cut off. As soon as the pressure drops at all below the normal, both water and fuel are supplied in proportionate quantities. The devices which regulate the fuel supply and the water supply are positive in their action, contain no delicate parts, and depend for their operation only on temperature and pressure, forces which are absolute in their behavior. External atmospheric or climatic conditions in no way influence the action of the regulating devices."

Steam cars of several other American designs are in successful operation, each possessing distinctive features of its own. The general principles of the steam car are also described under the heading Motor Car, which see.

STEAM CAR HINTS AND TIPS

Points of Steam Car Driving.

In using a steam car having a boiler, it is most important to see that a proper level of water is maintained, and this cannot be secured if the tank is allowed to get empty. Therefore, in strange country, keep on the safe side, and fill up as opportunity offers. Even when such a car is standing with only the pilot light burning, it is necessary to watch the gauge glass. And it is also important to see that the pilot light does not get extinguished on these occasions, otherwise when the driver lights up again he may set fire to fuel that has escaped, the car, and anything else within range. Failure of water means certain burning of the boiler, and possibly explosion. If you find you have let it get lower than you ought, do not get flurried, but pump the water in gradually until you have brought it up to the proper level, and—be more careful in future. Soft water should be used to prevent furring; and as a partial cure for the same trouble, at the end of each run the steam should be allowed to fall to about 50 pounds, and then the boiler should be "blown down" with it. The gauge glass should be similarly cleared several times in a day's run.

These precautions do not all apply to a generator such as the White; but whatever the boiler or generator is like, do not fail to empty it and all pipes in frosty weather.

Another cardinal maxim for steam car users is, lubricate freely. Under favorable conditions there is no object in running the slide valve its full stroke; one may notch up to a considerable extent without materially reducing the speed, the expansiveness of the steam being more fully availed of while the expenditure of fuel and water is reduced. Be sure to keep the boiler well supplied with water while climbing hills, using the hand pump if necessary. In starting a White or driving it up a long hill, turn the steam direct into the low-pressure cylinder as well as into the high-pressure.

But the marked differences in steam car construction make it difficult to give satisfactory general directions. The instructions given by the makers should be carefully mastered and followed in every case.

Some of the following paragraphs apply only to steam cars of early design—many of which, however, are still in use. Some of the difficulties referred to are obviated in the most modern steam cars.

The Engine Bearings.

The main bearings of the engine and the connecting-rod ends should be examined occasionally. In the White engine the eccentric straps and sheaves have balls between them, which reduce wear and so maintain the accuracy of the valve-setting—a very important item. When replacing a defective ball, it is better to replace the remaining ones in the bearing if there is any doubt about their not being exactly the same size as the new one.

Lubrication.

The engine in steam cars may easily be ruined through defective cylinder lubrication. Mechanical and automatic feeding of the oil is almost a "sine qua non," especially with superheated steam. Condensation lubricators are uncertain in action, frequently flooding the cylinders with oil and then leaving them dry, and a few miles of dry running with hot steam may score the cylinder walls badly.

The mechanical feed usually fitted is very efficient, but if the oil well is allowed to get empty, an oil lock often takes place in the pipe leading to the steam chest, and the pump refuses to work after refilling. The remedy is to disconnect the pipe from the steam chest, where there is usually a coned joint, and work the pump plunger up and down by hand until oil drips through freely, and then to replace the pipe—a matter of a few minutes.

While on the subject of oiling, it may be mentioned that it is a good tip to keep a small supply of cylinder oil in a can hang up close to the engine or boiler, and to replenish the oil well as soon as the car comes in, so as to avoid the troublesome delay in pouring out heavy oil when cold: this applies especially in winter. The cylinders will be very freely oiled if the lubricator is about three parts emptied after thirty or forty miles running, when it can be conveniently refilled at the same time as the water tank.

Engines.

None of the earlier steam engines have large enough bearing surfaces; the crossheads especially are inadequate, and wear rapidly. As soon as there is any play between the crossheads and slides trouble is likely to occur. The cylinders in time will wear oval, necessitating reboring and new pistons and rings. The rear slides will show more wear than the front ones, since all the pressure of the crossheads is against the former in forward running. Compensation is effected when the wear is slight by packing up the slides with thin hard paper, but the parts will probably need scraping true, as the wear is not even, being most pronounced at the top and bottom opposite ends. It may happen with ball-bearing connecting rod ends that tightening the adjusting cone fails to cure any "shake" there may be, and if the cones are otherwise good it is possible to grind down the face of the cone on an emery wheel, so that it screws up farther and drives the balls out against the race. If they are softened for the purpose of being worked in a lathe and rehardened, they may warp and not screw on again nicely.

Superheating Steam.

This is one of the greatest improvements in light steam cars, but is apt to cause trouble in some of the engines constructed for wet steam. The Weston type of superheater, which is fixed between the boiler and throttle valve, is far better than one between the latter and the engine, the temperature being less extreme, and the throttle controls the car better, even with this. Some have found, however, the heat sufficient to melt the solder in the joints of the feed water heater, causing the original packing in the cylinder heads and valve chest cover to leak. It is said that soft copper is better, and this would save the renewal of the other material, which, of course, involves pulling the engine to pieces and a great amount of time and labor. The engine glands need more attention with dry steam. Care should be taken that the springs which prevent the collars from unscrewing are really effective, as they sometimes get bent away when the tightening up is done with a screwdriver, and being in a very inaccessible position this may not be noticed. When once well packed and screwed up, the glands should only need a few threads of asbestos added from time to time. Sometimes special packing washers are supplied. The addition of graphite to the asbestos is an improvement.

All glands and joints should be kept under observation, as a little water continually lost, or a little steam leaking, may cause some surprise as to the capacity of fuel and water tanks. Leaking joints have long been among the handicaps of steam cars, and it seems a pity that ground unions are not used more in parts which are likely to be taken apart, as they require no packing, and their attachment to the pipe can be a permanent joint screwed up very tight. Pipes should everywhere be as springy and flexible as possible.

Boilers.

The fire tube boiler in conjunction with a superheater has some points in its favor in comparison with a flash generator, especially in regard to the length of life, which, however, is greatly dependent on the care with which it is treated.

The water gauge in the form usually seen is troublesome to watch, and, owing to the smallness of the pipe leading to it, is very apt to get choked and give a false reading. If the water does not rise briskly in the glass when the gauge is "blown off," the driver had better beware of a burnt boiler. Sometimes blowing off fails to clear the pipes for some time, and it is then better to risk flooding the boiler than burning x, the gauges frequently clear themselves after a journey of some miles when more or less choked at the start. There are, however, forms of gauge that are very easily read, especially at night.

The fire tube boiler is not very workable with certain water arrangements, unless there is a perfect system of oil filtration, for a small quantity of oil in the boiler will do harm, but is of no consequence in the flash tube form. Blowing out the boiler constantly and the use of water that does not leave deposit are the best means of keeping it in good condition. This is one of the difficulties in touring, and the flash boiler is not affected in the same way, no deposit being left in the tubes. Water is conveniently taken into the tank with a small injector, and the end of the hose is usually provided with a fine strainer, which prevents any foreign matter getting into the tank.

Burners.

If the burner has a vaporizing tube passing through the fire, or kept hot with a pilot burner, it is quite easy to use heavy fuel oil. There is not much difference in working between this and the more expensive quality of spirits, except that the vaporizer requires cleaning more often, and also, of course, the bypass. These were so unhappily arranged in some early cars as to necessitate removing the fire-box and unscrewing several joints, which could easily be avoided by a more intelligent scheming of the connections, and, as a matter of fact, is avoided in all steam cars that have survived at the present time.

If there is iron wire in the vaporizer, it should not be packed so closely when inferior spirit is to be used. A superheater diminishes the necessity for a large "fire," as there is usually plenty of steam with the fuel valve very slightly open, and there is no need for a higher pressure than 30 lbs. in the tank. Some find 10 lbs. sufficient if the vaporizer is clean. A steam air pump in consequence is not a very important accessory, although useful on a long journey when the tank is full of spirit at the start. In its absence, it is necessary to pump the air pressure to about 60 lbs., which pressure rapidly falls in the first ten miles, and if there is a separate bypass burner, it will need turning on a little more to compensate for the drop in pressure, or it may go right out. We are assuming that the driver starts with a high pressure to avoid pumping up on the way, but if there is a steam or mechanical air pump he need not do this, but can set it going at any time for a few minutes, and keep the air gauge at an even pressure.

The Effect on the Bodywork.

The coachwork of a steam car is more likely to get spoilt than that of a gasolene car. The heat from the flue and escaping steam are injurious to a highly finished body. The boiler, therefore, should not be blown off in the usual way, a much better method being to have a few yards of rubber tubing to screw on the boiler connection, and thus lead the escaping steam and water away from the car. The end may conveniently be put into a drain or the open end of a pipe.

The absence of dust-raising properties in light steam cars is a great point in their favor; very little is noticeable when traveling fast as compared with gasolene cars with bodies nearer the ground.

Economical running is best attained by working at a fairly high pressure and cutting off with the reversing handle whenever the road conditions and traffic permit.

Water Gauge Valves.

If users of steam cars ever notice their water gauge at a standstill while under steam, they should without delay try the lower check valve to see that it has not become seated. These check valves have above them a small handwheel, the screwing down of which releases the valve. It is possible for this to happen and the boiler tubes to get burnt as a consequence.

Care of Crosshead Guides.

Take particular care to see that the crosshead guides of a steam car engine are plentifully supplied with oil, and that undue wear does not take place. These guides have to take the angular thrust from the connecting rod, and if they become much worn there is a danger of the piston rod bending in an extreme case. However little the wear may be on the guides, the bending movement distorts the packing in the stuffing box, causing it to leak. Constant repacking will keep the cylinder steam tight at the stuffing box, but the real cause of the trouble lies in the bending of the connecting rod.

Fitting New Gauge Glass.

To put in a new water gauge glass of the ordinary steam engine type, first remove the broken glass and take off the packing nuts. The indiarubber rings which form the watertight joint must be removed and, if damaged, replaced. The packing nuts should be put on the new glass, open ends outward, and the packing rings slipped on to the ends of the glass, which should then be placed in position. Screw up the packing nuts carefully. The automatic check valves will be down on their seats, and must be released. To do this, screw down the small handwheel above each valve three or four complete turns, which will release the valve. Unscrew the handwheel to its original position. If the gauge glass is put in while the boiler is under steam, release the lower check valve first to admit water. Steam is liable to crack a new glass.

Straining the Water.

Always strain the water as it is put into the tanks of a steam car; failure to do this sometimes results in a feed pump becoming choked and failing to act.

Blow Off After Fifty Miles.

Blow off fire tube boilers after running about fifty miles. It prevents the formation of scale, and so keeps the steaming powers of the boiler at their best. Before blowing off turn out the burners, otherwise the heat is liable to start the fire tubes at their lower ends.

Use of Expansion.

Drive with the engine linked up as much as possible. This gives the slide valves a short travel, resulting in an early cut-off, which enables the best results to be obtained from the expansive qualities of the steam. For hill-climbing the valve requires its greatest travel, to deliver a bigger volume of steam to the cylinder.

Start a Steam Car Slowly.

Always start a steam car slowly, and run slowly for the first few minutes. Water always remains in the steam pipes and in the engine itself, from the condensed steam of the previous run. This water must be got rid of first, and the cylinders, etc., warmed up before the engine is capable of doing its full amount of work.

Starting Up Steam Generators.

When starting up steam generators always be careful to have the vaporizer well heated. Slow fires and dirty burners are the result of insufficient heating.

Steam Car Bearings—See under Steam Cars, above.

Steam Car Burners—See under Steam Cars.

Steam Car Crosshead Guides, Care of—See under Steam Cars.

Steam Car Lubrication—See under Steam Cars.

Steam Car, The White—See under Steam Cars; also under Motor Car.

Steam Chest—A closed space attached to a steam engine cylinder, from which the valves admit the steam to the cylinder. The term is also used to denote the reservoir for steam, whence the steam pipes lead from a boiler; but the more general term for such a reservoir is a "header" or "drum."

Steam Cock—See Cocks.

Steam Engine—See Engines; also Steam Car, under Motor Car; also Steam Cars, under letter S.

Steam Engine, Compound—See Steam Cars.

Steam-Engine Cycle—See Steam Cars.

Steam, Expansion of—See under Expansion.

Steam, Gasolene and Electricity, Comparative Advantages of—See under Electricity, etc.

Steam Gauge—A gauge which is used to record the pressure of steam. An almost universal method adopted is that known as the "Bourdon." In this the steam is led to a curved pipe, this curve forming part of a circle. One end of the curve is anchored to the instrument, the other end is connected by a link to a small rack and wheel or pinion. The rack pinion is on a little spindle which carries outside a pointer or hand. This pointer can travel over a scale separated into divisions showing different pressures—generally in pounds to the square inch. When the steam is led into the curved tube the latter will, according to the steam pressure, try to assume a straight line and will thus draw the rack along and operate the pointer on the scale.

Steam Generator—See Steam Boiler.

Steaming at the Radiator—See under Circulation.

Steam Jacket—See Jacket.

Steam, Live—Steam available for the performance of work in an engine.

Steam Pipe—Any pipe which conveys steam can rightly be called a steam pipe, but generally the term is used to denote the pipe conveying steam to the engine, while the pipe conveying it away is called the exhaust pipe.

Steam Port—A port or opening for the admission of steam to a cylinder.

Steam Pump—See Pumps.

Steam, Superheated—See under Steam, above.

Steam Valve—See Valves.

Steam, Wet—Steam holding water mechanically suspended.

Steatite—See Soapstone.

Steel—In automobile construction steel is used extensively, and its superior strength, as compared with iron, renders it indispensable in many parts where great strains have to be borne.

The principal difference between wrought iron or cast iron and steel consists in the proportion of carbon introduced into the latter, which can be adapted to suit the particular requirements of the part it is used in, producing the qualities of hardness, toughness, and elasticity, suitable for chains, shafts, springs, channel framing, etc. Wrought iron is pure iron without carbon in it, it is tough and can be bent hot or cold. Steel is iron with a little carbon in it, in consequence of which it is capable of being tempered by chilling, and of being case-hardened by the addition of extra carbon to the outside layers of a manufactured object. It is tough, strong, and not brittle until it has been specially tempered or hardened. These qualities may be enhanced or modified by the addition of nickel, chromium, etc. Cast iron is iron with a good deal (relatively to steel) of carbon in it. One of the effects of this quantity of carbon is that cast iron can be melted at a fairly low temperature and poured into molds whose shape it assumes. It is very brittle and not tough. It can, however, by a process of decarbonizing be rendered malleable. When this has been well effected it can be bent if carefully handled.

In case a motorist has occasion to make a repair, it is worth while to revert more in detail to the question of modern steel, which is the all-important substance in motor-car work. The following are some of the uses to which modern steels of different compositions are put:

Shafts, Bearings, and Forgings are made of nickel steels containing 1 to 6 per cent of nickel and 0.25 to 0.4 per cent of carbon.

Valves are made of nickel steel containing as much as 32 to 36 per cent of nickel and 0.12 to 0.20 per cent of carbon.

Bearings are made of chrome steels (1 to 1.2 per cent carbon and 1 to 2.5 per cent chromium) after quenching from 800° C. in oil, and afterwards from 850° C. in water.

Springs (and also change-speed gears) are made of silica steels having 0.3 to 0.7 per cent carbon, 2.5 to 0.8 per cent silicon, 0.35 to 0.7 per cent manganese.

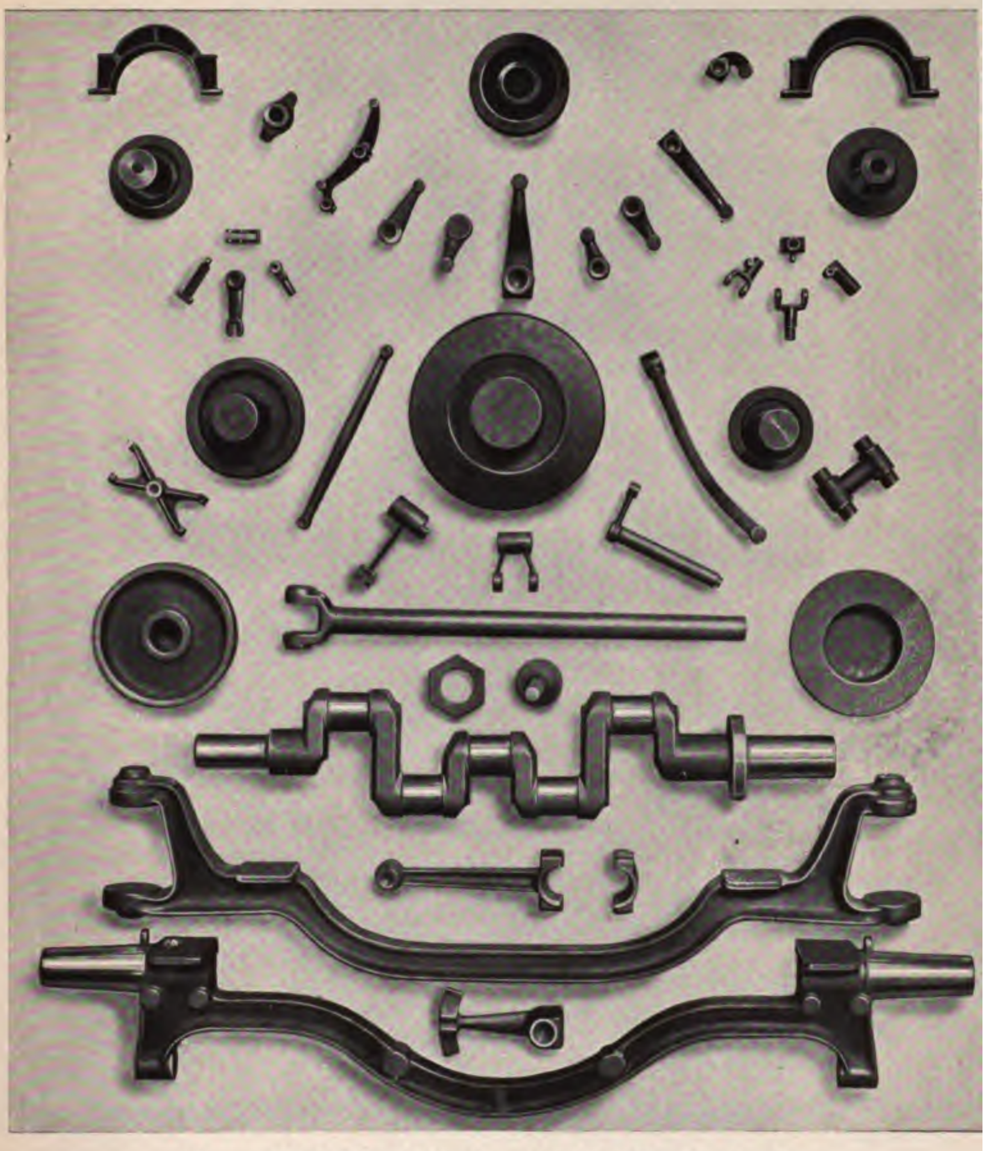
It is to be noted that the proportions of carbon and silicon vary inversely, and that these steels are very sensitive to the heat treatment.

The amateur must not imagine that because he has bought at great expense what is vaguely called a "nickel steel" axle to replace his broken one, that he will therefore make a very good job of his repair. It is imperative that he should inform himself of the exact composition of the steel, and also of the exactly determined heating and quenching treatment which will give him the result he desires. No general rule can be given, as the heat treatment varies enormously with the amount and kind of the ingredients. Examples are given below:

A back axle of nickle steel which the amateur would be disposed to get case-hardened at the part where the roller bearings run, and which indeed might have been so treated with advantage if the metal had been an ordinary carbon mild steel, is liable to be damaged and reduced to the level of the cheapest material by any such unsuitable temperature treatment as may very likely be given to it by persons instructed to do the case-hardening.

The commonest types of chromium nickel and nickel steels, that is, those which are most universally used, contain percentages of carbon and other metals as follows:

(a)	Carbon	0.25	per cent to 0.45 per cent.
	Nickel	2.5	per cent to 2.75 per cent.
	Chromium	0.275	per cent to 0.60 per cent.



Chrome Nickel Steel Forgings Used in The Car De Luxe.

This steel when quenched from 850° C. and reheated to 350° C. is strong and tough, and so hard as to permit of dispensing with case-hardening for many purposes.

(b) Carbon	0.25	per cent	to	0.45	per cent.
Nickel	5.0	per cent	to	6.0	per cent.
Chromium	0.5	per cent	to	1.0	per cent.

This steel when simply quenched has a high elastic limit and good elongation (18 per cent to 11 per cent), and is specially used for shafts and journals. It may therefore be taken that a person entirely ignorant of what kind of "nickel steel" has been supplied to him, has some chance of being right if one or other of the last two treatments be adopted. In the absence of scientific knowledge of the subject, however, it is wiser and far cheaper to content oneself with the best quality of "mild steel" of commerce, the treatment for which is known everywhere.

Varieties of Steel.

The following are a number of the varieties of steel, most of which are employed by different makers in motor car construction:

Alloy Steel—An alloy of iron with another metal, such as nickel, chromium, manganese, etc., the compound being named after the metal used.

Basic Steel—Steel formed by the basic process or use of a basic-lined Bessemer converter in making steel and certain kinds of iron.

Bessemer Steel—Steel produced by forcing atmospheric air into cast iron. Its most remarkable property is that of becoming very hard when heated to redness and suddenly plunged in cold water. If reheated to redness and left to cool gradually, it becomes soft like the original iron. Between these two conditions any degree of hardness may be attained. Hence, in the manufacture of steel articles they are first forged into shape and then hardened and lastly tempered by a proper degree of exposure to annealing heat, which is often judged of by the color of a thin film of oxid which appears on the surface.

Blister Steel—Steel of blistered appearance formed by heating bar iron in contact with carbon in a cementing furnace; also called Blistered Steel.

Carbon Steel—Common steel the properties of which have been derived from carbon; opposed to Alloy Steel.

Cast Steel—Blister steel which has been broken up, fused in a crucible, cast into ingots, and rolled. The blocks of steel are melted in crucibles of refractory clay, and the molten metal is poured into ingot-molds of cast-iron. These are opened to let out the red-hot ingot, which is then passed to the rolls.

Cement Steel—Blister steel; steel made by the process of cementation, which is the conversion of iron into steel by heating the iron in a mass of ground charcoal and thus causing it to absorb a certain quantity of the charcoal without fusion of either material.

Chrome Steel—Steel containing a small percentage of chromium. It oxidizes quicker than common steel.

Chrome Nickel Steel—Steel alloyed with a small amount of nickel and chromium to increase its hardness and malleability.

Chromium Steel—Same as Chrome Steel.

Crucible Steel—Cast steel made in crucibles.

Damask Steel—Originally the steel of Damascus. It is a laminated metal of pure iron and steel, of peculiar quality, produced by careful heating, laborious forging, doubling and twisting.

German Steel—Formerly steel made from siderite or spathic ore. The name now applies to any steel made in Germany.

High Steel—Steel containing a large quantity of carbon.

Homogeneous Steel—Cast Steel.

Low Steel—Steel deficient in carbon and hence not easily tempered, if at all.

Manganese Steel—A very hard and yet ductile steel containing some 12 per cent of manganese.

Mild Steel—Same as Low Steel.

Native or Natural Steel—An imperfect steel produced by the reduction of iron ore by a burning coal-seam.

Nickel Steel—A variety of cast steel containing a little nickel. It is very well suited for making exhaust valves, etc.

Open-Hearth Steel—Steel manufactured by the Siemens-Martin or open-hearth process. In this process melted cast-iron is converted into steel by the addition of iron ore or wrought iron and manganese, the whole being exposed to heat in an open-hearth furnace, or reverberatory furnace using gas as fuel.

Puddled Steel—Steel obtained from cast iron by puddling.

Shear Steel—A variety of blister steel, so called from being used in making shears and other cutlery as well as important machinery parts.

Silicon Steel—A special steel containing a percentage of silicon.

Siemens-Martin Steel—Open-hearth steel.

Soft Steel—Same as Mild or Low Steel.

Special Steel—Steel whose hardness is due to an element other than carbon.

Titanic Steel—Steel alloyed with titanium.

Tungsten Steel—A hard, malleable, magnetic steel containing a small percentage of tungsten.

Vanadium Steel—A special steel alloyed with vanadium, a metal discovered by Lefstrom in 1830. The latter is not oxidized either by air or water and its presence in steel adds to the durability of the alloy. It also increases the tensile strength.

Steel, Angle—Steel rolled or pressed into such shapes as the letter L or V, used for forming the joints of iron plates by riveting, for framework, etc.

Steel Frames, Pressed—See Frame.

Steel, Tincture of—An alcoholic solution of chloride of iron.

Steering—The act or operation of guiding the movements of an automobile in the desired direction by the movements of a hand wheel or hand lever controlling the steering gear. See Steering Gear.

Steering and Control, Learning—See Driving.

Steering Arm—One of the arms by which the front wheels are turned in the required direction by means of the drag-link or steering bar and steering pivots, or knuckles.

Steering Bar—The drag-link connecting the steering arms on a front axle.

Steering Box—The box which contains the worm and segment, or screw and block, steering mechanism.

Steering Columns, Control Levers on—See Operating Mechanism.

Steering Connections, Worm and Sector—See Steering Gear.

Steering Gear—The steering gear of an automobile forms in itself a most important branch of construction, and constitutes a vital point, inasmuch as both the ease of steering and the safety of the occupants depend on its efficiency and strength. Originally attempts were made to construct the steering gear of a self-propelled vehicle in the same way as that of horse-drawn carriages—namely, by pivoting the front axle at the center, but this method was so clumsy and uncertain in action that it was abandoned for the Ackermann system as soon as that was invented. The Ackermann short axle system, as it is called, is an attempt to obtain the correct geometrical deflection of the wheels when describing any curve.

To show that this is necessary, let us suppose that A, B, C, and D (Fig. 1) are the extremities of the parallel axles of a car, and that the car is describing a circle about the center O. Let us suppose that the rear axle AB is at any instant coincident with the radius of the curve about O, so that wheels at right angles to the axle AB are tangential to their separate tracks.

But if the rear axle is radial to the curve about O, the front axle CD, as may be seen from the figure, is a considerable angle from the radial line, and, consequently, in order that the wheels at the extremities C and D may be tangential each to its separate track, it is necessary that each wheel must take up some position not at right angles with the axle. But it is known that, geometrically, a tangent to any circle is at right angles to the radius of the circle at that point, so that the wheels at C and D must be both at right angles to lines drawn from O to C and O to D. A short consideration will show that these lines correspond to the centers or axles on which the wheels must run.

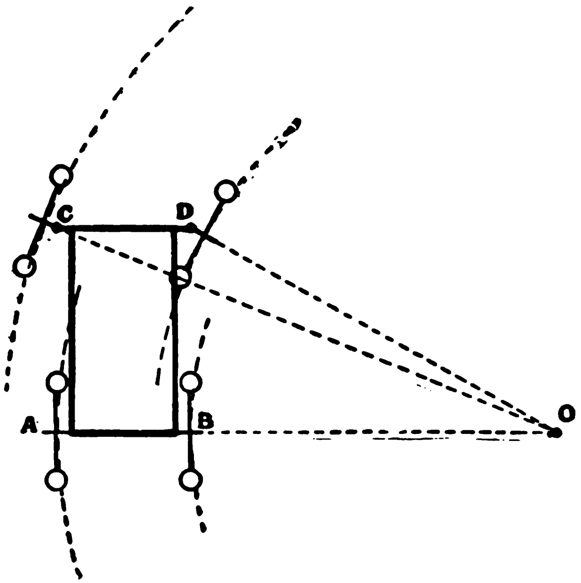


FIG. 1.—THE FUNDAMENTAL PRINCIPLE OF MOTOR CAR STEERING.

From this we can formulate the principle on which all steering gears are designed—namely, that if the direction of the steering axes be produced they should meet in the line of the rear axle produced.

Ackermann was the first to demonstrate this principle or, rather, he was the first to suggest any practical method for obtaining the above result, and although many inventors have tried to improve the steering arrangements by modifying his gear, yet, so far, the Ackermann system holds its own.

Fig. 2 gives a diagram of the system. AB is the front axle of the car, and at A and B short axles, AC and BD, on which the wheels revolve, are pivoted. These axles have arms, AF, BE, rigidly forged with them, or otherwise attached, and at such an angle that if AF and BE be produced, they will meet in a common point in the center of the rear axle.

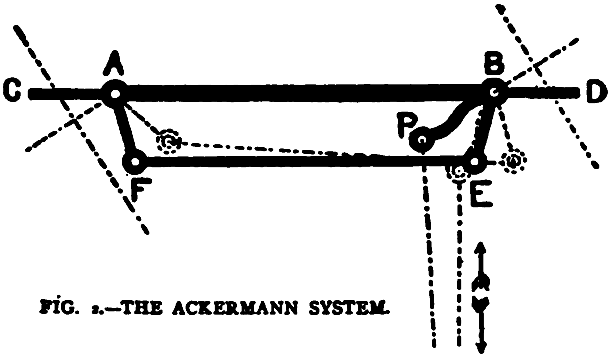


FIG. 2.—THE ACKERMANN SYSTEM.

The extremities of these arms, F and E, are connected by a rigid rod, FE, so that the distance between F and E is at all times constant. Motion is given these levers by a second arm, BP, attached to one of the short steering axles, which is operated by a second distance rod.

Sometimes the polygon AFEB is made in front of the axle instead of behind. Many attempts have been made to construct a link motion between the axles, that will give more geometrically correct results than that illustrated; but so far the result has been small in comparison with the extra complication and expense involved.

It is, above all things, necessary that the steering of an automobile be steady, and, in order that this steadiness may be obtained, some device must be employed which inequality of road surface will not affect. This is obtained in practice by employing a worm gear for operating the steering arms attached to the axles of the front wheels. The irreversibility of the worm gearing provides against shock being carried back to the driver, and, at the same time, the screw action of the worm provides a most powerful control over the direction of the wheels.

Fig. 3 shows a standard arrangement.

In place of the worm and segment sometimes a nut with sliding block is used. The screw engages with an internal thread inside the block, and the outside of the block has a slot which engages with a lever which actuates the steering wheels. In the case of the Napier steering gear, the block which is moved upward and downward in its case by means of the worm on the end of the steering wheel, has on its edge teeth which engage with a tooth segment and so operate the steering gear.

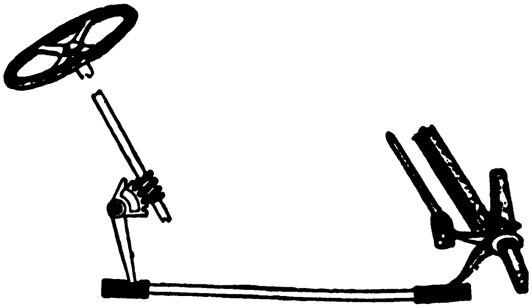


FIG. 3.—WORM GEAR FOR OPERATING STEERING.

Another point about the arrangement of the steering gear is that in order to insure easy steering, the axis about which the wheel turns to steer the car should, if produced, cut the point on the ground which the wheel touches. This has been provided for in a number of ways. The type illustrated under "Axle" is the one generally adopted.

Another point which is of great importance is that the links which connect the steering lever to the steering arms should have their joints very strongly constructed and should be protected against any possibility of becoming deranged or falling apart. A great many special methods of attachment have been invented for this purpose, and on all up-to-date cars it may be taken for granted that this danger has been well provided against. In our illustrations we show several forms of joints, connecting links, and levers. In Fig. 4 is shown the usual form of ball and socket joint. The end of the lever is turned into a sphere, and semi-spherical sockets in a cylindrical casing engage with it, these sockets being kept in constant engagement with the ball by means of the springs shown. In order to prevent any possibility of the rod dropping from the lever a stud is screwed into the end of the ball and provided with a cross pin. The cross acts as a stop in case the socket should be worn so far apart as to allow the rod to drop, in which case it will come in contact with the pin, and will be held.

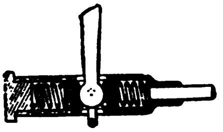


FIG. 4.

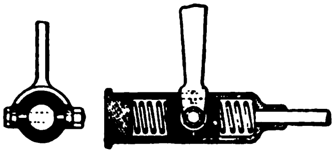


FIG. 5.

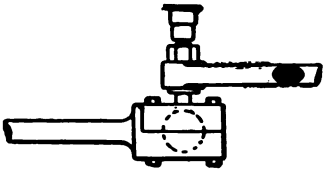


FIG. 6.

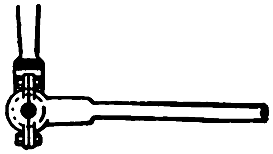


FIG. 7.

In Fig. 5 a similar arrangement is shown, but in this case the end of the lever is forked, and the pin passing through the ball also passes through the casing and is secured by a nut in the fork. In Fig. 6 is shown an entirely different form, in which the two spherical halves which hold the ball in position are coupled together by nuts and bolts. In Fig. 7 the ball is on a pin passing across the end of the fork on a lever, and the rod is held on the ball by means of the half cap secured by two nuts and bolts. One of the simplest and yet strongest steering joints is that shown in Fig. 8. It is a knuckle joint connected together by pins and nuts. These links and joints should always be carefully covered with leather and packed with grease. As an additional precaution against any of the joints slipping out, these leather cases can be applied in such a manner by clips around the arms and rods, that even in the case of derangement they would hold the parts together until the car could be pulled up. See "Steering Gear" in Repairs and Adjustments.

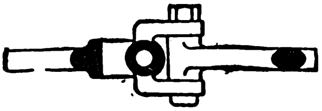


FIG. 8.

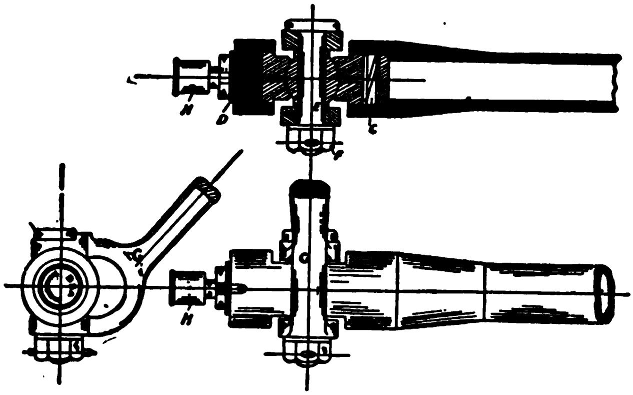


FIG. 9.—THE B.S.A. STEERING LINK.

In our illustration, Fig. 9, we show a modern type of steering gear as introduced on the B.S.A., a European car. In this there is a cylindrical casing containing the half spherical sockets pushed up by the spring shown at C, the joint being held by the screw in the end of the cylindrical casing D. It will be seen that the ball is formed in the shape of a cylindrical piece having partially spherical sides, that part which comes into contact with the sockets being spherical in shape. Through the ball is passed the bolt E secured by the nut F. This also passes through the fork on the lever shown at G. It will be seen that even if the ball socket joint were to become detached or the locking screw D were to become displaced, the casing could not fall away from the lever. This illustration also shows the method of lubrication. Both the sockets are drilled through their centers with a lubricating hole, and a screwed down grease lubricator H is provided at the end, so that by screwing down this lubricator, grease will be forced into the bearings.

The manufacture of the steering gear of cars calls for great attention and the best material and workmanship, since so much depends upon it.

In those cars where cars are fitted with front springs which are hung on shackles at their rear end, the link between the steering lever and the steering arm on the road wheel forms a rigid connection between the chassis and the front axle, but if the front wheels encounter an obstacle and the springs are depressed, there is a tendency for the front axle to go backward relatively to the chassis, which would result in the wheels being turned sideways—the direction in which they are turned depending on the arrangement of the lever which turns the off-side wheel. To overcome this difficulty, and so assist in more easy steering on rough roads, some designers have shackled their front springs at the forward end, the result being that the center about which the front axle rises and falls is approximately the center on which the steering rod is connected to the steering lever, and therefore the movement of the axle up and down and fore and aft on the car has no great tendency to intérfere with the steering. See Useful Information.

ANOTHER VIEW OF STEERING.

The simplest form of steering gear is that which we find in the horse carriage, namely, a cross axle pivoted to the carriage in the center, and carrying a running wheel at each end; the steering lever takes the form of a pair of shafts, and the carriage follows the direction of the lever as controlled by the driver through the horse, or by the horse alone, as the case may be. This form of control, when the lever is put into the hand of the automobile driver, is dignified by the name of bathchair steering—though apparently without due deference to the peculiar gait of that essentially select vehicle.

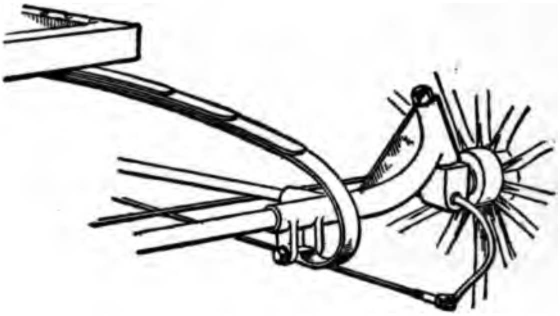


Fig. 10—Inclined Steering Center.

Anyway, no modern motor car is constructed with central pivot steering, though the lever tiller is sometimes retained in a few gasolene cars and some electrics.

Stub Axle Pivots.

The great objection to the central pivot is that the road wheels act at too great a leverage. Not only must the front axle be very strong if it is to support all the weight of the front part of the car at its center, but in the case of either wheel striking an obstacle, the axle is almost certain to be deflected, and the car possibly upset. These difficulties are met by providing the front axle with two pivots, one near each end. The main portion of the axle remains permanently at right angles to the length of the car. But the short end pieces—called stub axles—may be turned about their respective pivots, and the road wheels, mounted thereon, with them. If the axes of the pivots are vertical, the wheels will always have a tendency to turn outward, though the actual movement is prevented by the steering connections. But the tendency even may be obviated, and the deflecting influence of obstacles guarded against, by inclining the pivots so that their axes are directed to the points of contact between the wheels and the ground. If the axes be raked backward, the wheels will tend to cant over to right or left in turning corners, thus presenting a better resistance to the centrifugal forces set up on these occasions. Commonly, however, vertical pivots are used.

To insure the wheels deflecting together in steering, each stub axle is provided with a forwardly or a rearwardly directed arm, and these arms are coupled together by a crossbar hinged to the ends thereof. Thus the deflections of one wheel are imparted to the other through the arms and crossbar.

The Ackermann System.

But unless carefully designed, stub axle steering is liable to set up lateral drag on the tires; and, as we have seen, the tires have quite enough to do to manage their own business without indulging in works of supererogation. In taking a corner, all the wheels of the car should stand tangentially to curves struck from a common center, which lies in a continuation of the back axle. The rear wheels, being at right angles to this axle are naturally in the proper tangential positions, but the front wheels require putting there. The steering wheel nearer the common center should describe part of a smaller circle than that described by the other wheel, which is further from the center. Hence the inner steering wheel must always be turned at a sharper angle than the outer one. This may seem an awkward problem, but a simple solution is found in the so-called Ackermann system: Supposing the steering wheels to be set straight; the arms projecting forward or backward from the stub axles are inclined, so that lines passing through the axis of each pivot and the axis of each crossbar hinge will, when produced, intersect at the center of the back axle. This arrangement is found to give the requisite relative angles to the wheels when traversing curves, and should be followed carefully in the design of the steering gear.

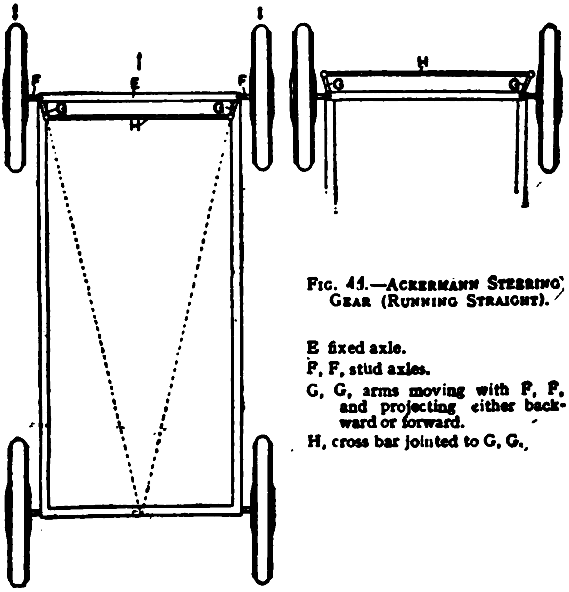


FIG. 41.—ACKERMANN STEERING GEAR (RUNNING STRAIGHT).

E fixed axle.
F, F, stud axles.
G, G, arms moving with F, F, and projecting either backward or forward.
H, cross bar jointed to G, G.

Whether the crossbar should be in front or behind the fixed axle is a moot question. There are points for and against both arrangements. A combination of the two is probably the best solution.

When the car is running straight forward, the front wheels, as well as the back wheels, should make perfectly parallel contacts with the ground. If the longitudinal axes of the contact areas converge or diverge, the wheels will scrape or "spin" as they rotate, and the tires will wear quickly.

Steering Wheel and Connections.

The operation of steering is now almost always performed by manipulating an article which, unfortunately, bears exactly the same name as certain other parts of the car—the steering wheel. There is virtue in this wheel, but it is no "magic circle," for a handle-bar may possess precisely the same leverage, or more. But where the benefit of the wheel comes in is that it is equally convenient to handle to whatever angle it is turned. And the convenience is considerable, in view of the fact that, in order to give the driver great control of the steering, the hand steering wheel is made to turn through a much greater angle than is imparted to the road steering wheels. Or, in other words, the steering is considerably geared down.

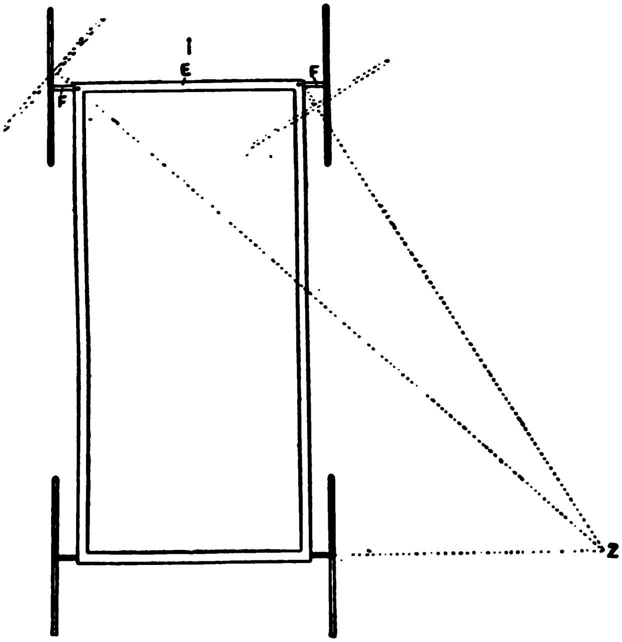


**Fig. 12. Ackermann Steering Gear (Running on a Curve).
E, fixed axle. F, F, stud axles. Z, center of curve.**

Not only is the driver given greater power over the steering wheels, but the connections are (or, at least, should be) so devised that the steering wheels can exert no force at all against the driver. This problem has several solutions, of which the following is an example. On the lower end of the steering column (which is surmounted by the steering wheel) is fitted a worm or coarse screw thread, which engages in the teeth of a sector, forming one arm of a bell crank. The other arm of the bell crank is coupled up by a rod to an arm on one of the stub axles. When the worm is turned by the driver, the bell crank is rocked on its pivot, and the movement is transmitted to the stub axle and its road wheel. The other road wheel follows suit by reason of the crossbar connection. The movement of the worm thus steers the car. But suppose, by running up against a street-car track or some other obstacle, the road wheel attempts to deflect; it pushes at its stub axle and arm, and the arm pushes at the bell crank, the sector teeth on which push at the threads of the worm. But these threads stand so nearly at right angles to the thrust of the sector teeth that the worm will not turn on this occasion, and so the road wheel pushes in vain. The steering gear is thus said to be irreversible, and the prevalence of irreversible steering accounts for the fact that outwardly inclined steering centers are not more common. There are other ways of constructing irreversible steering gears than the worm and sector, just as there are other systems of differential steering than the Ackermann, but they or their equivalents should always be in evidence.

Points for Consideration.

There are one or two other points to look out for in the steering gear. There should be plenty of "lock" for the wheels, which, with an inconsequence not unusual in our language, means that the wheels shall be quite free to be deflected through a large angle, so that one may turn the car in an ordinary road without an inordinate number of reversings.

See also that the position of the steering wheel suits you personally. These things ought to be adjustable, but seldom are. The joints of the steering gear should be very strong, well secured, adjustable, and inclosed against dirt and wet. They should also be provided with proper means of lubrication. The steering column is mounted in a hollow pillar projecting up from the frame. The pillar should be rigidly fixed, or it will be liable to vibrate violently while the motor is working.

Steering Gear, Examination of—See Overhauling.

Steering Gear, Examining Second-hand—See Choice of a Car.

Steering Gear, Irreversible—The modern form of gear which does not slip or reverse of its own accord and thus prevents the steering wheel from being forced backward in the driver's hands against his will, when the road wheels meet an unexpected obstacle, etc. See under Steering Gear, above.

Steering Gear Repair, Makeshift—See Makeshifts on Tour.

Steering Gears—See Operating Mechanism.

Steering-head—Same as Steering Knuckle.

Steering-hub—A form of box-hub inclosing a steering pivot.

Steering Joint Lubrication—See under Lubrication.

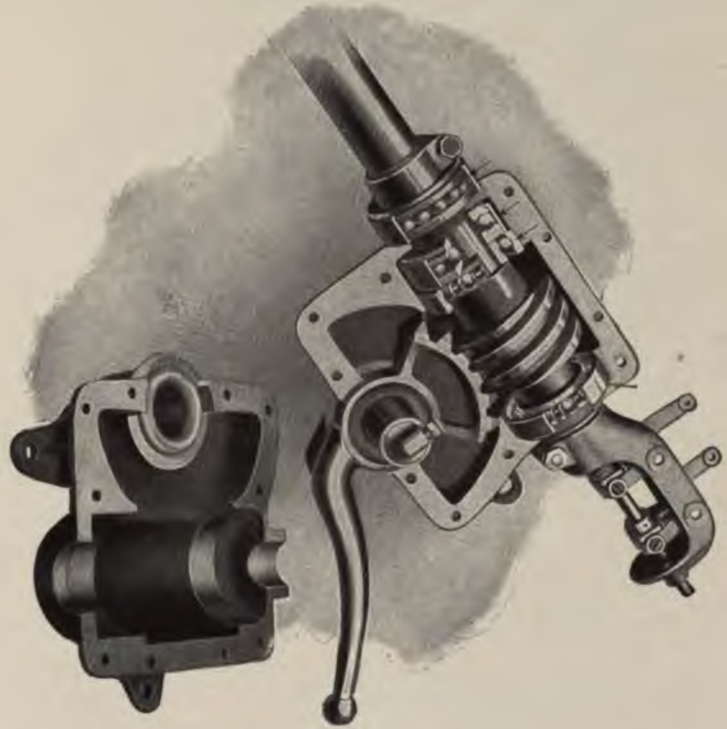
Steering Knuckle—One of the joints or pivots which connect the rods and levers of steering mechanism. See Steering Gear.

Steering Knuckle, Broken—See Miscellaneous Roadside Repairs.

Steering, Learning—See under Driving.

Steering Lever—A tiller or handle used to operate the steering gear on some gasolene and electric cars. Also applied to the lever operated by a steering wheel.

Steering Link—A term used to denote either of the two links which connect the different members of the steering gear. The front steering link connects the two arms of the steering head or sockets, so that the turning of one causes

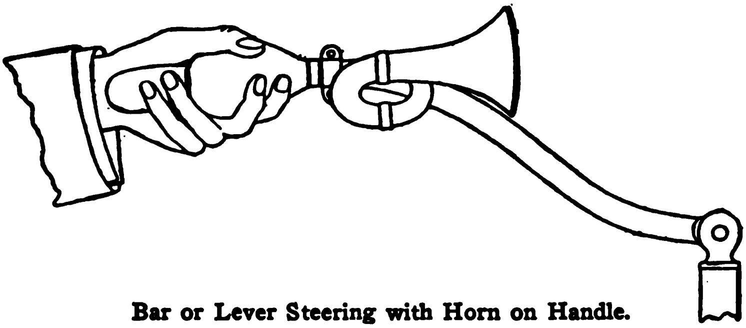


Irreversible Steering Gear—The Car De Luxe.

Holsman Light Delivery Wagon.

Holsman "Gentleman's" Automobile.

the other to turn. The back steering link connects the right-hand arm with the lever operated by the steering wheel.



Bar or Lever Steering with Horn on Handle.

Steering Mechanism—See Operating Mechanism; Steering Gear.

Steering Post—The hollow column or tube at the top of which the steering wheel is situated. It serves also to inclose the rods operated by the ignition lever, etc., on the wheel.

Steering, Reversible and Irreversible—See Reversible Steering; also under Steering Gear.

Steering Rod—The rod actuated by the steering-post and which in turn operates the lever connected with the steering pivot.

Steering System, The Ackermann—See Steering Gear.

Steering Wheel—The wheel close to the driver's seat by which the steering gear of an automobile is operated and the direction of the car is guided. It is in the form of the rim of a circle, usually with four or more arms or spokes, is mounted on a hollow steering post and carries various control levers. See Operating Mechanism.

The steering wheels are usually made of metal, steel, brass, aluminum, etc., with a trimming of wood, often mahogany, and form an ornamental as well as indispensable adjunct to a car.

It is the common practice to "dish" steering wheels, that

is, to construct them with the rim higher than the hub or boss, giving the spokes or arms a curved inclination upwards.

Steering Wheel and Connections—See under Steering Gear.

Stem—The guide-rod by which a valve is operated; a tool-handle; a bar to which the bow of a falling hood is arranged.

Step—One of the belt faces of a speed pulley or a similar face on a cone or stepped gear; the lower brass of a journal-box or pillow-block; the socket forming the lower bearing of a vertical shaft.

Stephenson Link-motion—See Steam Cars; also The Steam Car, under Motor Car.

Stepped—Furnished with steps or something resembling steps, as a stepped gear.

Stepped Gearing—See Gear, Stepped.

Stepped Pulley—A pulley made in sections of graduating diameters; a cone-pulley.

Stern—The after part of a ship or boat.

Stiff Valve Springs—See under Loss of Power.

Stirrup—In machinery, a metal strap in the form of a loop, used as a support. Also called Stirrup-piece.

Stock—The brace which holds a bit for boring; the block which holds a plane-bit; an adjustable wrench or handle for holding screw-cutting dies.

Stones, Driving Over—See under Driving.

Stop—In machinery, any contrivance to limit or put a stop to motion of a part.

Stop-cock—See under Cocks.

Stoppage—See Involuntary Stops.

Stoppage, Causes of—See Diagnosing Causes of Stoppage; also Repairs and Adjustments.

Stops, Involuntary—See Involuntary Stops.

Stop Valve—See Valves.

Storage Battery—A secondary battery or accumulator; any combination of storage cells or units.

The term "accumulator" is preferred by many electricians when referring to the batteries commonly used on automobiles and is sometimes used as a synonym for "storage battery" in this work, "secondary battery" or accumulator being perhaps a more correct designation of the apparatus. The so-called storage battery has the property, when once charged from a primary source, of giving out an electric current until exhausted, when it must be recharged. Where the term "accumulator" is used in the Cyclopedia, in deference to those who prefer it, the reference is therefore to the storage battery, popularly so called in the United States. For a full description see Battery.

Storage Cell—The unit of a storage battery; an accumulator. See Battery.

Storm Apron—See under Apron.

Storage of a Car—When it becomes necessary, for any reason, to store a car for any length of time, several points should be attended to. It is well to empty gasolene, lubricating oil and water tanks completely. In the case of the water tank, this is particularly necessary in winter time, otherwise freezing may take place, resulting in cracking of the cylinders and damage to the pump and radiator. If the car has to be stored for some considerable period, it is advantageous to take off the tires and store them separately in bags in some place with an even temperature and away from the light. If it is convenient to take the tires off, the weight of the car should be jacked up; the tires should be deflated and wrapped round with canvas wrapping. All levers and moving mechanism should be well greased to prevent rust, and this is best done with ordinary petroleum jelly, which may be had in quantities at a low price. This can be brushed on with an ordinary painter's brush.

If the upholstery is of leather it should be rubbed with a flannel cloth dampened with linseed oil, and the same may be done with the coach varnish, using only the very slightest amount of linseed oil—boiled linseed oil being right for the varnish and raw linseed oil for the leather. The car should then be covered with a linen cover reaching down to the ground, and fastened down by means of tapes to the front and back of the car.

In the case of cars fitted with limousine bodies or brougham bodies, which can be taken down, it is best to keep all windows down, so as to allow the air to circulate freely through the upholstery of the car. Where hoods are used, it is quite essential that they should be fully stretched, and if the hoods are of patent leather, this should be dressed with any of the dressings sold for the purpose. A good dressing for patent leather can generally be obtained from harness makers, etc. It will be essential, of course, before using the car again, to put it into proper order by replenishing the gasolene and lubricating tanks and the water tanks, and generally carefully overhauling it for running, as described under Overhauling. Also see Laying up a Car.

Straight-edge—A flat bar having one edge perfectly straight; used to ascertain whether a surface or edge is true.

Strain—In mechanics, any definite alteration in the form or dimensions of a given portion of matter caused by a stress.

Strainer—An appliance for straining a liquid. Strainers are to be found in different parts of a car, such as in the feed apertures of gasolene and oil tanks. Gauze strainers are also used to intercept impurities in the gasolene pipe, a filter or strainer generally being placed in or near the carbureter for this purpose. Strainers should always be employed in filling up with either water or gasolene. In the case of gasolene, the wire gauze of which the strainer is made should be so fine that, although gasolene will easily run through it, it will prevent the passage of water.

Straining Gasolene—See Gasolene.

Strake—A continuous line of planking or plates on a vessel's side, reaching from stem to stern.

Strand—One of the twists or parts of which a rope is composed; also any single thread, fiber, etc.

Strap—A band of metal, usually curved, to bind and hold parts of machinery; also an iron plate to connect two or more timbers to which it is bolted or screwed.

Strap-bolt—Same as Lug Bolt.

Straps, Rebound—See Miscellaneous Roadside Repairs.

Streak—Same as Strake.

Stress—In mechanics, (a) an internal elastic force constituting the resistance offered by a solid body to deformation produced by an external force; (b) any force exerted between contiguous bodies or parts of bodies, causing a strain, and named according to its direction or mode of action; as Tensile Stress, tending to draw or pull the parts of a body asunder; Compressive Stress, tending to crush a body; Transverse or Lateral Stress, tending to bend it and break it across, the force being applied laterally, and acting with leverage; and Shearing Stress, tending to cut it through.

Striker—The lever attached to the rocking shaft in make-and-break ignition; when acted upon by the interrupter catch, it breaks contact in the cylinder.

Strip—To lose the thread, as a screw, or have the screw stripped off, as a screw-bolt; to lose the teeth, as a cog wheel.

Stripping the Wheel—See under Care and Maintenance.

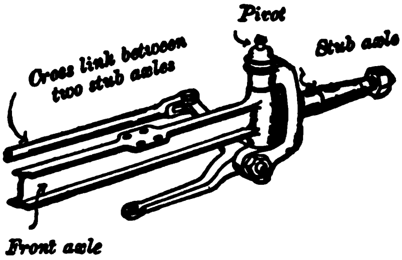
Stroke—The distance through which the piston travels in the cylinder is known as the stroke. It is determined by the length of the crank, and is always twice the crank length. The length of the stroke has an important bearing on the power and efficiency of the engine; if the length of the stroke is known, as well as the diameter of the cylinder and the speed at which the engine runs, its horse power can be readily approximated. The different strokes of the piston for the cycle of operations in an internal combustion engine are known respectively as the induction stroke, the compression stroke, the firing or power stroke, and the exhaust stroke.

Stroke, Induction—See Stroke, above.

Stroke, Power—See Stroke, above.

Strut—A wood or metal brace or support to receive direct thrust, pressure or weight in construction.

Stub Axle—The short axle which is so pivoted that the front or steering wheels can be deflected.

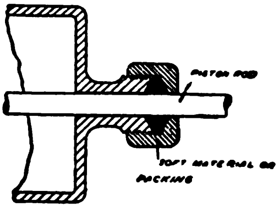


Stud—A short cylindrical piece of metal, screwed at both ends. One end is screwed into a casting or other metal member, the other end being passed through a hole in the metal to be bolted up. A nut on the end of the stud screws it up tight.

Cylinders are usually held down to the crank case by means of studs screwed into the latter and passing through the holes in the flange at the bottom of the cylinders.

Stud Bolt—A bolt with a thread at either end, to be screwed into a fixed part at one end and to have a nut screwed on it at the other.

Studded Tires—Tires having their outer material partially covered with studs of metal, to prevent skidding, etc. See Tires.



Stuffing-box.

Stuffing Box—The female portion of a gland, or, rather, the bore into which the gland proper slides. See Gland.

When a piston or other moving rod passes through a hole which must none the less be airtight, a soft material is pressed round the rod by a screwed cap. The material is often asbestos cord or one of the many patent packings.

Small tubes are often joined together tightly in a similar way by a packed coupling. It is as well to avoid using asbestos for gasolene pipe joints; the fiber finds its way into the pipe, and once it has traveled to the spray holes of the carbureter it will give a good deal of mysterious trouble, such as misfires, bad mixture, loss of power and total stoppage. Such a trouble is easy to cure, but the tyro may take a long time to localize it owing to its irregular recurrence.

The shaft of the water pump generally passes through a stuffing box, which may be packed with tow and a little grease.

Stupes—The name sometimes given to hot water bandages used for warming up a carbureter when, owing to very cold weather, the gasolene will not vaporize sufficiently to enable the engine to start. Also useful for thawing a frozen pump.

Suberine—The cellular tissue of cork after the various soluble matters have been removed by the action of water and alcohol; a kind of cellulose.

Sub-frame—A so-called "false frame" or cradle attached to a chassis for the support of the power plant, etc.

Suction—The effect of the increase in capacity of a comparatively air-tight chamber which, owing to the atmospheric pressure outside, results in air or gas being forced into the expanded chamber to fill up the partial vacuum created, as in the case of a piston in an internal combustion engine. Suction is solely due to the difference in pressure between the air or gas inside the cylinder and that outside it.

Suction Pump—See Pumps.

Suction Stroke—The first piston stroke in the four-cycle system, which draws the charge into the combustion chamber.

Suction Valve—An atmospheric or automatic valve. See Valves.

Sullage—In foundry work the scoria or slag of molten metal.

Sulphated Screws—See Care of Battery, under Battery.

Sulphating—The chemical action which takes place on the plates in a storage battery. It is due to improper usage, to either charging or discharging at too high a rate, or to the cell having been neglected. See Battery.

Sulphur—A non-metallic element existing in many forms, being found in great abundance in the mineral kingdom, sparingly in the vegetable kingdom, and still more sparingly in the animal kingdom. It occurs in nature as a yellow, brittle, odorless and tasteless solid. In chemistry, it unites directly with most of the metals by the application of heat, thus making sulphids. It is used widely in the pure state for vulcanizing rubber, in the manufacture of tires, etc.

Flowers of Sulphur.—The condensed vapor of heated sulphur.

Roll Sulphur.—A commercial name for purified sulphur in stick form.

Sulphuric Acid—Oil of vitriol, a heavy, oily, colorless, very corrosive liquid, $H_2\ SO_4$ produced commercially by burning sulphur in atmospheric air, and passing the sulphurous oxid formed into a lead chamber along with the vapor of nitric acid. A reaction takes place between the two; the sulphurous oxid becomes oxidized into sulphuric oxid, the nitric compound being reduced to nitric oxid, which again becomes oxidized, and acts as a carrier of oxygen between the sulphurous and sulphuric oxids. On evaporation in leaden pans it reaches a specific gravity of about 1.7, but on further concentration in a platinum retort it forms normal sulphuric acid, having a specific gravity of about 1.8. The addition of water to the strong acid in the proportion of 1 to 4 raises the temperature of the mixture from 0 to 100. In many cases organic substances are broken up or destroyed by it, as in the case of woolen and cotton fabrics, etc. Of all acids it is the most extensively used in the arts, and is in fact the primary agent in obtaining almost all the others by disengaging them from their saline combinations. It is much used as an electrolyte in batteries. See Battery.

Sump—A well at the lowest point of the crank case or gear box, into which oil is drained from the bearings, and from which the oil is pumped back again by the pump in the case of forced lubrication. See Internal Combustion Engine; Lubrication.

Sun-and-Planet Gear—Gearing in which the axes of the wheels revolve around a common center. See Epicyclic Gear.

Sunk Screw—Same as Countersunk Screw. See Screws.

Superheated Steam—See Steam.

Superheater—An appliance used in steam engine practice in order to raise the temperature of the steam before it passes to the engine to insure its being dry. This is done by causing the steam to flow through a coil of tubes while it is in direct contact with the flame of the furnace. In some cases the feed-water is superheated before being led to the boiler in the same manner, but this practice is not common in the case of steam motor cars.

Superheating—The raising of the temperature of steam after it has passed out of a steam boiler and before it is used in a steam engine. See Steam.

Supply of Gasolene—See under Gasolene.

Supply Pipe—See Feed Pipe.

Surface Carbureter—See Carbureter.

Surplus of Gasolene—See under Loss of Power.

Surrey—A type of carriage body having two or three seats set transversely of the frame, with access from the sides. It usually has a top and resembles a phaeton, but has no side doors.

Suspension—The way in which the car chassis is hung or supported on the axles through the medium of the springs is known as the suspension; also the method of attaching gear-boxes and engines in the chassis frame. The "three-point suspension" is one in which the part suspended, either the car, its engine, or the gear-box, is attached in three places. In the case of engines and gear-boxes such a method of suspension entirely prevents any twisting or distortion due to distortion of the chassis, and is adopted by a large number of manufacturers, especially in the case of a gear-box.

Suspension, Three-Point—See Suspension, above.

Swage—A tool or die for shaping metal when hot, as in a stamping-press or on an anvil, etc. Also a similar tool used for bending or twisting cold metal slightly, as in setting saws. Stamping-presses are sometimes called swaging-machines.

Swage Block—A heavy block of iron perforated into holes of different sizes and shapes, and variously grooved on the sides; used for heading bolts and swaging objects of larger size than can be worked on an anvil in the ordinary way.

Sweep—The reach or range of any continued motion or stroke, as that of a piston.

A pattern shape used in molding.

Switch—A simple device for breaking the low tension circuit in the case of the coil and battery system of ignition, or of short circuiting the current in the case of a low tension magneto. See Ignition.

Switches are made in various forms, but the chief points sought to be attained in all are a broad and tight contact between the stationary and movable parts, so that no resistance is offered to the current, and quick action when breaking the current to prevent sparking.

Chopper Switch.—A switch for cutting off the current from one cylinder at a time for purposes of ignition testing.

Knife Switch.—A metal blade used to make contact by insertion between springs.

Pin Switch—A switch in the form of a pin, inserted in a hole in a plate to form a contact.

Plug Switch.—A switch operated by the insertion of a metallic plug between two insulated metallic segments connected to a circuit and separated by air-spaces for the insertion of the plug-key. Used by its removal as a means of preventing unauthorized interference with a car or motorcycle when left standing alone.

Two-way Switch.—A switch used where two batteries are employed, to connect up either one or cut off both.

Switch, Charging from Ordinary—See under Care and Maintenance.

Switch, Electric, The—See under Ignition.

Switch, Loose—See Missing Explosions.

Switch Off—See under Motor Stopping.

Switch, Short Circuiting at the—See under Ignition.

Swivel—A device fitted to a wire or rod to allow the same to twist or turn freely on its axis while pulling the body to which it is attached; a twisting link in a chain.

Swivel Joint—A section in a chain or a joint on a rod which allows the parts to twist without distortion or kinking.

S-wrench—A wrench or spanner shaped like an S, having an adjustable jaw at each end at different angles.

Synchronize—To cause to agree in time of occurrence, as the sparks of an ignition system in two or more cylinders of an internal combustion engine. See Ignition; Timing.

Synchronizing Ignition Points—See under Valve Setting and Ignition Timing.

Synchronism—The concurrence of two or more events in time; the act of being simultaneous.

System—An assemblage of things adjusted into a regular or harmonious whole, as a system of ignition, of water cooling, of power transmission, etc.

Systems, Water Circulation—See under Circulation.

T

T—In mathematics, the abbreviation of Time.

Table—The part of a machine-tool on which work is placed to be operated upon.

Table Anvil—A small anvil adapted to be screwed to a table for bending plates of metal or wires, making small repairs, etc.

Tachodometer—An instrument for registering the distance traveled and also the speed of an automobile or other vehicle. The best tachodometers register both "trip" and total distance traveled and show speed at all times. They are usually actuated by the revolutions of a front wheel of the car through a flexible shaft. The Veeder tachodometer, a typical device, shows exact speed at all times from zero to 62 miles an hour. It has only one moving part and is ball-bearing throughout. The indicators are usually set on the dashboard.

Tachometer—A speed indicator. An instrument for registering the velocity of a machine by the number of revolutions a minute of some revolving part. See Speed Indicators.

The tachometer was originally a contrivance for indicating small variations in the velocity of machines, one form consisting of a cup having a tube opening into its center, both being partly filled with mercury or a colored fluid and attached to a spindle. This device, being whirled around by a revolving part of the machine, the whirling motion by centrifugal force caused the mercury to recede from the center and rise upon the sides of the cup. At the same time the mercury in the tube descends and the degree of its descent is measured by a scale attached to the tube. When the velocity of the machine is lessened the mercury rises in the center of the cup and also rises proportionately in the tube.

Tachometers used in motor car practice are now constructed to operate on a magnetic principle, as the Warner

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Auto-Meter, which is illustrated on another page, as well as on the centrifugal principle.

Tackle—A device for raising, lowering or moving heavy weights; the rigging and apparatus of a ship. A block-and-tackle is a hoisting pulley including block, sheaves, rope or chain and hooks for holding.

Tail On—To join in a continuation; to dovetail together.

Take Nothing for Granted—See paragraph under Lubrication.

Taking a Car Apart—That there is great educational value to be derived from taking a car apart is a fact not so well realized as it might be by the average motorist. Indeed, in no other way is it possible, even for the expert, to operate a machine with as perfect confidence and assurance as when such operation has been preceded by the complete dissection of the car, or at least of one in every respect similar to it. No man, no matter what his mechanical knowledge or attainments, is capable of telling, simply from acquaintance with the exterior of a mechanism, just which of the many possible constructions is employed in its make-up, and without such knowledge it is totally impossible to run the mechanism intelligently without the possibility of doing it damage. Nor, unfortunately, does the average instruction book help matters much, these books rarely going into the details of construction to the extent that many consider it desirable that they should. It is not, of course, in any sense to be recommended that the average purchaser of a car, without knowledge or facilities for such work, should undertake to dismember the machine for no better reason than that of the small boy with the watch, who "wanted to see the wheels go around." But taking apart and putting together a car in a properly equipped shop, under the supervision of an expert, if need be, is a very different matter, and, though it may dirty the hands and test the patience, will afford an experience that no motorist worthy the name will forego permanently. And, in this case, what is good for owner is good for chauffeur, so the least a wise employer can do, if unwilling to learn his car himself, is to provide its driver with every facility for becoming as perfectly familiar with its details as with its general construction. If distance and time permit, even a trip to the factory will not be misspent by any one.—Motor Age.

Taking Down the Clutch—See Overhauling.

Taking Down the Engine—See Overhauling.

Taking Down Piston and Rings—See Hints and Tips, under Overhauling.

Taking Off the Cylinders—See Hints and Tips, under Overhauling.

Take-up—A mechanical device for tightening belts, ropes, etc., to save lost motion or power.

Talc—A soft, unctuous mineral consisting of silicate of magnesium, mixed with small quantities of potash, alumina, oxid of iron and water. Also called Soapstone or Steatite. When powdered it is used to prevent the tubes of pneumatic tires from sticking together; also for electrical insulation.

Tang—A projection, tongue or shank for fastening a tool, etc., to a handle.

Tangent Screw—A screw which acts in the direction of a tangent to an arc or circle.

Tangent Wheel—A road-wheel the spokes of which are set tangent to the hub.

Tanite—A material composed of scrap leather, emery, cement, etc., used to make grinding and polishing disks or wheels.

Tank—A storage vessel or reservoir for holding a liquid or gas. See Tanks below.

Tank, Auxiliary Gasolene—See under Gasolene.

Tank, Feed—See under Tanks.

Tank, Fitting Float to Gasolene—See under Gasolene.

Tank, Tire—Same as Air Bottle.

Tanks—Reservoirs for carrying liquid or gas on a car.

Gasolene Tank—This is the reservoir containing the necessary fuel. These tanks may be made either for gravity or pressure feed. A gravity feed tank must be placed above the level of the carbureter and at such a height that when the car is on a steep hill, and the supply of spirit in the tank is small, the flow to the carbureter is not interfered with. For this reason the supply pipe should be fitted just above the lowest point. A small vent hole must be drilled in the filling bung or filling stopper to prevent a vacuum forming as the gasolene is drawn off. Pressure tanks may be placed in any convenient position, as the pressure keeps the supply constant, but the bung must be gas-tight. It is essential to use a fine gauze funnel for filling the gasolene tank, as any grit which gets into the tank may choke the spraying nozzle of the carbureter. Never by any chance permit water to enter the gasolene tank or pipes, especially if the tank is a tinned iron one, this kind being often fitted to cheap cars. The least particle of rust occurring might cause much trouble with the carbureter. When filling up always take care that there is no dirt on the top of the can likely to fall into the funnel and get washed into the tank; also see that the air vent, which is usually in the filling stopper, does not get blocked up. If this filling stopper gets lost, do not use a cork in its place, as cork dust is likely to get into the tank and cause carbureter troubles. From this it will be seen that the great necessity with gasolene tanks is to prevent the entrance of foreign matter.

Water Tank.—The reservoir for the cooling water. Many modern cars have not a tank proper, this having been found unnecessary owing to the increased size and efficiency of the radiators, which thereby require less water. A small reservoir, combined with the radiator, which carries the filling stopper, usually suffices. Incrustation forms a serious hindrance to the cooling of the cylinders if hard water is used. This trouble can be alleviated to a certain extent by adding about half a tea-cupful of kerosene to the water in the tank, which has the effect of forming a slime, which can be washed out. This treatment should only be applied occasionally. In order to prevent freezing of the water in the tank and circulation system, a percentage of glycerine, etc., may be added to the water. See Cold Weather; Anti-freezing Solutions.

Oil Tank.—The lubricating oil reservoir. As oil tanks usually hold a sufficient quantity for long distances, care should always be taken that they contain enough lubricating oil to obviate the necessity of filling up on the road.

Feed Tank.—A tank carried on steam cars to contain a supply of water to feed the boiler. The feed tank is provided with a screw-topped opening for filling. Two pipes are fitted, one from the bottom of the tank leading to the feed pump, which forces the water into the boiler against the head of steam. The other pipe serves as a by-pass, so that the pump, which acts continuously, can either fill the boiler or merely circulate the water back to the tank by means of the by-pass. Thus the quantity of water passed into the boiler can be regulated.

Tank Capacity.

It is often useful to know the capacity of a tank, and the following formulæ will enable it to be determined:

A cubic inch contains .003607 gallons.

A cubic foot contains 6.23 gallons=6¼ approximately.

A cubic foot contains 28.3 liters (French or metric).

To find the contents in gallons of a rectangular tank:

Where A=length in inches.
" C=height " "
" B=depth " "

$$\frac{A \times B \times C \times 6.23}{1728} = \text{capacity in gallons.}$$

To find the contents of a circular tank in gallons:

Where D^2=diameter squared in feet
" B =length in feet

$$D^2 \times .7854 \times B \times 6.23 = \text{capacity in gallons.}$$

The capacity of a tank can be very accurately ascertained by weighing it full and empty of water at normal temperature. The following is the formula:

$$\frac{A-B}{10} = \text{capacity in gallons.}$$

Where A equals weight of tank filled with water in pounds and B equals weight of tank empty.

A gallon of water at normal temperature weighs 10 pounds.

Tanks, Charging—See under Driving.

Tanks, Gasolene, Repairing—See under Gasolene.

Tantalum—A rare metallic element occurring in various combinations. Used as an alloy with steel.

Tap—A faucet or cock. A tap is fitted in the gasolene pipe for cutting off the supply, and in the circulating system for letting the water run off. Compression taps or cocks are fitted in the combustion heads of many engines to enable kerosene or gasolene to be squirted in, and to facilitate timing. See Cock.

Tap—A machinists' tool for cutting an internal screw thread, as on a nut.

In electricity, a conductor attached as a shunt to a large conductor; a derived circuit for carrying off a share of a main current. To tap an electric wire is to treat it in such a way as to draw off current.

Tap Bolt—A bolt with a square head, to be screwed into a part instead of passing through it and taking a nut.

Tap, Compression—See Tap.

Tape, Insulating—In making joints in the wiring of an electrical ignition equipment it is necessary that they should be thoroughly insulated, and for this purpose insulating tape is very convenient. This tape can be had in various widths covered with a solution of indiarubber and gutta-percha in a sticky condition, so that when wound round a joint one turn naturally adheres to the other: while being waterproof it also acts as an insulator and prevents short circuits.

Tape-line—A graduated ribbon of metal or tape, used in measuring length, etc.

Taper—A gradual decreasing of size in an elongated body.

Taper Pin—See Pins.

Tappet—A projection on a moving part of machinery, designed to touch and move some other part at certain intervals.

Tappet Gear—Mechanism employed originally upon steam engines of the beam type for operating the valves at definite intervals. It may be correctly applied to the mechanism operating the magneto igniters on some motors, or to the arrangement employed for working valves located in the cylinder head. See Ignition: Internal Combustion Engine.

Tappet Rod—A rod used for lifting the valves of internal combustion engines or for operating the striker in the case of the low tension magneto system. Also called **Push-rod**.

Tapping—The process of forming a screw thread in a hole. A light continuous knocking.

Tapping in the Engine—See under Driving.

Tap-plate—A steel plate pierced with screw-threaded and notched holes of various sizes, for cutting external threads on blanks.

Tar—A thick, dark-brown, viscid, oily liquid produced in the dry distillation of organic bodies and of bituminous minerals. It is increasingly used in roadmaking and resurfacing roads to prevent dust.

Tar Paving—See under Dust, Roadmaking, etc.

Tarmac—A roadmaking preparation of British origin—not tar macadam. See under Dust.

Tarred Macadam—A form of macadam paving for roads in which tar or preparations of tar are used to make an even surface and prevent dust.

Tarvia—A tar preparation used for laying dust on roads. It has been extensively used in all parts of the country with particular success, as demonstrated by the good condition of many boulevards and park roadways on which it has been used since 1907.

Taxicab—A motor vehicle for public hire, with a cab or carriage body, equipped with a taximeter for the prevention of overcharges on the part of the driver and to record the distance traveled.

Taximeter—An instrument fitted to taxicabs or automobiles for public hire to indicate to the passenger the distance traveled and the amount of fare that has been earned at any stage of the trip. These instruments are now fitted to public hacks in many of the larger cities of the United States and are common in like use in Europe.

T-bar—A bar of metal, as iron or steel, stamped like a T in cross-section.

T-bolt—A bolt whose head is formed of a transverse piece, so that with its body it makes the outline of a letter T.

T-cart—A form of phaeton of which the body resembles a T.

Tedge—In foundry work, the ingate.

Tee—Anything resembling the letter T in shape, as a pipe-joint.

Teeth—The cogs or projections on the face of a wheel which engage similar projections on another wheel; a rack, etc., in gearing.

Telford—A kind of paving invented by Thomas Telford, a Scotch engineer, consisting of large broken stones packed with smaller ones, the whole covered with a fine layer rolled hard and smooth.

Tell-tale—An indicator or "sight-feed" placed on the dashboard in some systems of motor car lubrication, so that the operator can assure himself that the lubricator is working properly.

Tell-tale Light—A small electric lamp by which a tell-tale indicator can be examined at night.

Temper—The state of a metal, particularly as to its hardness. The temper of steel depends on its hardness compared with its elasticity. The word temper is purely a relative term. For some purposes steel may be dead hard. Cast steels, heated to a dull red and plunged into water, become exceedingly hard and very brittle, and therefore can be used only for very few purposes as tools. To temper steel is to let this hardness down. This can be done by heating the steel to a dull red heat, plunging it in cold water, and then subjecting it to heat until its color begins to change from bright white to light yellow, dark yellow, a mixture of yellow and blue, purple and finally a deep blue. These different colors denote different stages of hardness, which are obtained if the steel is plunged into water exactly at the time they appear. The lighter colors indicate extreme hardness, the darker colors lesser degrees of hardness. It is necessary that the steel be made dead hard first. The same effect may be obtained by heating the steel to a known temperature, and plunging it through a certain depth of oil into water at a certain speed. Only expert steel users can determine the exact temperature or the exact color necessary for a certain purpose, and this varies with different steels.

Tempering—The process of imparting to a metal the desired hardness and elasticity. Also called Annealing.

Template or Templet—A pattern to which a part has to be made. It usually takes the form of a metal plate cut to shape, or a wire bent to the curve required. The pattern is laid against the object being molded, built or turned, so as to test the conformity of the object thereto.

Tenacity—That quality in bodies which enables them to resist a severe strain without breaking or splitting; cohesiveness or tensile strength.

Tenon—The end of a piece of timber which is reduced in its dimensions so as to be fitted into a mortise or inserted to join two pieces together.

Tensile Strength—The tensile strength of metal represents its resistance to elongation. In motor manufacture it is necessary that the steel used in the various parts of the mechanism should have a high resistance against both compression and extension.

Tension—In mechanics, the force which causes a substance to be drawn out against its internal resistance. Thus we have tension springs which act by the force of resistance to their elongation. Tension rods are those which sustain weight or keep parts in position, solely due to their tensile strength, that is to say, their resistance to elongation.

In electricity the term is used relatively in connection with electrical current. We have high tension and low tension currents. The low tension current has great volume, but is incapable of being, as it were, stretched across a gap. High tension current may be regarded as having less volume, but is capable of being stretched across a gap.

Tension, High and Low—See under Electricity; also Ignition.

Tension Rod—A tie-rod. See Tension.

Terminals—Metal connections attached to electrical instruments and similar appliances for the purpose of connecting the wires or "leads" of the electric circuit in a manner that shall allow of their being easily attached or detached. The term also includes the terminal connections arranged to be permanently attached to the ends of wires in order to provide for the more sure and easy connection of them to the electrical appliances. Of the former there are, generally speaking, two kinds—those in which the bared end of the conducting wire is passed through a hole in a brass or other metal pillar and clamped with a set screw, and those in which the wire is looped around a projecting screw and clamped tightly upon it by a thumb or other nut. See Battery; Coil; "Ignition" under Repairs and Adjustments.

Terminals, Induction Coil, Marks for—See under Ignition.

Terminals, Insecure—See under Ignition.

Testing a Car—See Dynamometer; also **Choice of a Car**; Purchasing a Car, etc.

Testing for Broken Circuit—See under Ignition.

Testing the Ignition—See Choice of a Car; Ignition.

Test Lamp—In order to determine the voltage which is being given off by a battery a small test lamp is often used. This is an incandescent lamp, which will just carry the four volts of current, and will, with this pressure passing through it, cause the filament to glow brightly. The resistance of the lamp is such that, if the voltage drops below four, the lamp will burn only very dimly. See Battery.

Tests of Compression—See under Compression.

Theory of Clutch Adjustment—See under Change Speed Gear.

Theory of the Engine—See Engines; Internal Combustion Engine.

Theory of Horse Power—See Horse Power.

Therm—A heat-unit; the amount of heat needed to raise one gram of water at its maximum density through one degree Centigrade.

Thermal Efficiency—The efficiency of the engine as determined by the heat-units transformed into energy. The thermal efficiency of the engine is its utmost efficiency; that is to say, the amount of power it can be made to develop from a certain number of heat-units given out by the fuel in a given time.

Thermal Unit—The heat-unit. See Heat.

Thermal Unit, British—See under Heat.

Thermodynamics—The department of physical science which investigates the laws regulating the conversion of heat into mechanical force or energy, and vice versa.

Thermo-electricity—Electricity produced by differences of temperature at the junction of dissimilar metals.

The branch of electrical science which treats of the properties and action of electricity developed by heat.

Thermo-syphon—Thermo-syphonic action is used in the case of many motor cars in order to circulate the water round the radiator and the cylinder jackets. It relies on the law which determines that water as it increases in temperature will rise; that is to say, if a vessel containing water is heated at the bottom the heated water will rise to the surface, and the colder water then will flow down to take its place, thus causing a constant circulation of water. This natural law is taken advantage of to keep the water circulating from the radiator round the jackets, so that in turn each particle of water will have been subjected to the cooling effects of the radiator. See Circulation.

Thermo-syphon Feed—The gravity feed of a system of water-cooling in motors. See under Circulation.

Thermometer—An instrument for measuring temperature, based on the property which heat possesses of expanding all bodies. The principal thermometric scales are Centigrade, Fahrenheit and Réaumur. In the first, the freezing point of water is 0° and the boiling point 100°; in the second 32° and 212°, and in the third 0° and 80°, respectively.

Thermostat—An automatic device for regulating temperature, depending upon the expansion and contraction of a piece of metal which, by such variation, controls the amount of heat. Used on steam cars for various purposes of regulation.

Thimble—A thimble-shaped coupling used to join the ends of tubes, pipes, shafting, etc.; also an iron ring with a hollow groove around its circumference.

Thimble Joint—A kind of permanent coupling made with a thimble.

Third Speed—See Change Speed Gear.

Thorn Catcher—Same as Nail Catcher.

Thread—In mechanics this term generally refers to the helical projection on a screw by means of which it may be screwed in to engage with a nut or with corresponding helical projections on the inside of a nut.

Three-point Suspension—See Suspension.

Three-quarter Springs—See Springs.

Three-square—Having three plane surfaces of equal width; applied especially to certain files of triangular cross-section.

Throttle—The throttle of a gasolene engine generally consists of a sliding piston in a cylinder or a rotating device in a cylinder, the sliding or rotating of which acts so as to cut off the passage leading from the carbureter to the inlet valve and hence controls the supply of mixture to the engine. See Internal Combustion Engine; Valves.

In steam engine practice it is the valve which controls the amount of steam passing from the boiler or generator to the engine.

Throttle, to—To cut off or reduce the amount of mixture or steam flowing to a gasolene engine or steam engine, respectively.

Throttle Connections Slipped—See under Loss of Power.

Throttle Control—The control of the speed and power in the engine by closing or opening the throttle.

Throttle, Foot—See Operating Mechanism.

Throttle, Hand—See Operating Mechanism.

Throttle, Steam—See Cut-off.

Throttle Valve—See Throttle.

Throttling Down the Engine—See under Driving.

Throw—The extreme movement of a slide-valve, or of a crank or eccentric, measured on a straight line passing through the center of motion.

Throw of Crank—The throw of the crank is the distance between the center of the crank and the center of the crank pin. It represents half the stroke of the piston by which the crank is rotated.

Thrust—In some parts of the mechanism of a motor car there is end thrust on some of the rotating parts. This is generally referred to briefly as "thrust." It occurs especially in the case of shafts which are driven from each other by bevel wheels. The bevel wheels try to crowd away from each other, and thus put an end thrust on the shaft on which they are mounted. Similarly, when the clutch is taken out of engagement against the pressure of the spring, end thrust is put on the shaft on which the clutch member slides. End thrust is generally taken up by thrust bearings, which may be either plain or of the ball-bearing type. See Bearings.

Thrust Collar—See Collar.

Thumb Nut—See Bolts and Nuts.

Thumb Screw—See Bolts and Nuts.

Thumping, Engine, at Gear Changes—See under Driving.

Tickler—A device by which the float of a carbureter may be manipulated in order to increase the flow of gasolene when starting the engine.

Tie-bar—A bar which forms a tie; applied to a drag-link, etc.

Tie-rod—A binding-rod or cross-tie. See Drag-link.

Tiller—The bar or lever fitted to the head of a rudder and used to turn the helm of a ship or boat in steering. A similar lever used in steering a motor car.

Tiller Steering—So named because the lever by which the car is steered resembles very closely the tiller of a boat. It is a hand lever to control the direction. Tiller steering was much used in the earlier cars, but is now practically discarded, except in electric cars, although it has always been a feature of certain European makes, even in some of the most modern types.

Timer—A device by which the occurrence of the electric spark that fires the charges in an internal combustion engine is timed; a contact-maker, contact-breaker or commutator. For a full description of these, see under their respective names. For the various methods of timing ignition, see Timing.

A timing apparatus for use in motor car racing, etc. See Timer, Trego's Mile, below.

Timer Contact Destroyed—See Missing Explosions.

Timer, Dirty—See Missing Explosions.

Timer, Ground at the—See Missing Explosions.

Timer, Gummed—See Loss of Power.

Timer, Make-and-break—See Contact-maker; Ignition; Timing.

Timer Set Screw Loose—See under Motor Stopping.

Timer Slipped—See Late Ignition, under Overheating; also Loss of Power.

Timer, Trego's Mile—A device by which the time in which a motor car runs a mile may be exactly ascertained; invented by Mr. F. H. Trego of Chicago.

The Trego electric timing apparatus was the official timing apparatus in several of the most important events held in America in 1908, when its practical success was established.

The greatest race ever held in America was that at Savannah, Georgia, on November 26, 1908, in which practically all of the most famous cars and drivers in the world took part. The Trego apparatus was used to get the time of these cars over a one mile stretch on which they attained speeds running up to 101.7 miles per hour. The machine stood the severe test well. The cars were running at the start one minute apart; but after a few laps were bunched so that as many as five would be between the start and finish of the mile stretch at one time. Even under these conditions, one hundred and thirty-eight of them were timed successfully, and cars were handled which were running but four seconds apart, even where one would pass the other between start and finish of the mile stretch.

The following describes the method of setting up and operating the Trego apparatus:

Setting Up the Ground Apparatus.

No. 18 piano wire is used for the wire across the road. It may be as high as 6 to 8 inches in its highest part, such as on

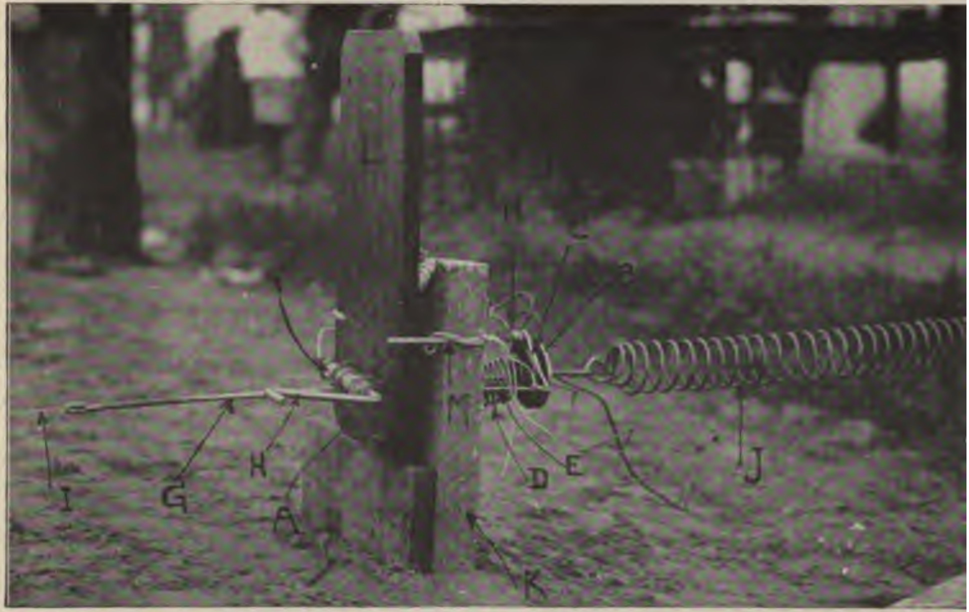


Plate 1.

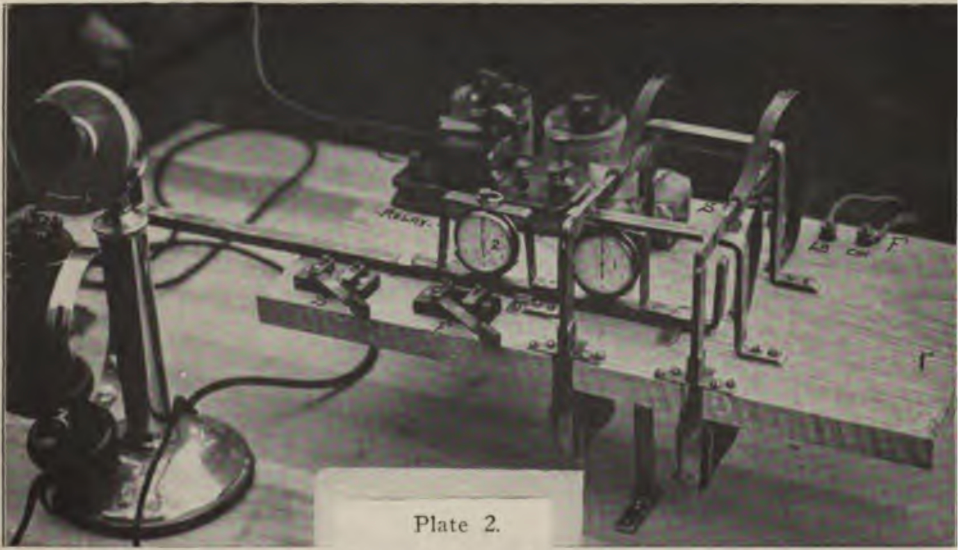


Plate 2.

The Trego Timing Apparatus for Automobiles. Invented by Mr. Frank H. Trego, of Chicago.

UN

the side of the roadway. Iron pins ⅜x6 inches may be driven into the roadway flush with the surface. Pass a strip of rawhide belt-lacing through the eye in the pin and embrace the wire with it so that the rebound will be controlled. This is not necessary for speeds under 60 miles per hour.

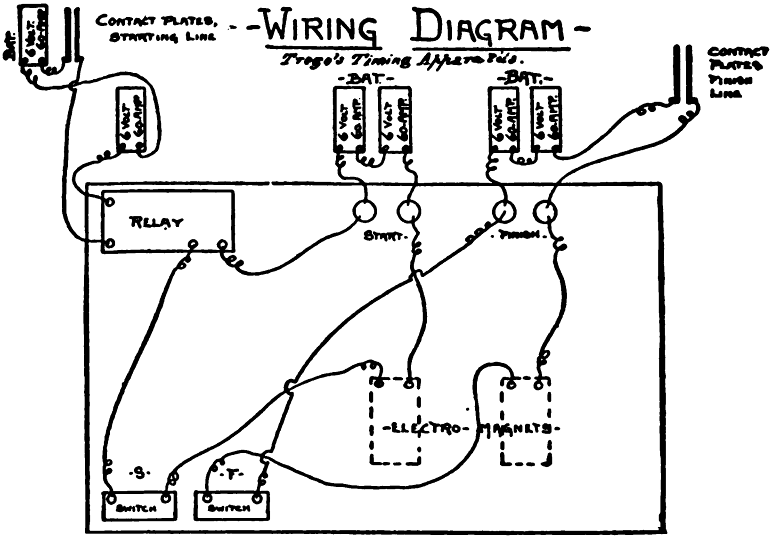
The wire across the road in Plate 1 is fastened to a 2x2 inch stake on the other side of roadway; it is then brought across through the loops and is fastened to the rod G. This rod G works free clear through the board L to the tension spring J, to which it is hooked. The brass plate B is secured from movement along G by a set-screw.

Free on the rod G and sliding along same is the brass plate C which is held out from the board L by the spring D. Strings E on each side of plate C lead through the board L to the small windlass F which is operated by the crank H and held in any position by the ratchet A. By winding up on the windlass, the plate C may be drawn away from the plate B and in operation this distance should be adjusted to about one-sixteenth inch; the spring D holding the plate steadily in any position in relation to plate B.

When the car runs over the wire I it necessarily pulls it slightly and thus the plate B touches the plate C, and as the wires from the battery and timing instrument are connected to the binding posts on these two plates, an electrical contact is made, thus completing the circuit and causing the current to flow through the electro-magnet on the timing instrument to operate the watch under the finish line.

The starting line is set up in exactly the same manner, except that the two wires from the binding posts on the plates run to a battery and the relay on the timing instrument, and from the relay to the battery, thus making a complete circuit to operate the relay. The secondary circuit from the relay is shown in the diagram for wiring (furnished by the maker) and operates the watch under the starting line arm through means of a local battery, stronger than that required to operate the relay.

In setting up the ground apparatus, care should be taken that there is not too much tension on the spring J as in that case the pull on the wire is not enough. There should be a good compression on the spring D to prevent the plate C from sticking to the rod G and being carried along with it, thus failing to make contact with B. Be sure that the rod G works perfectly free through the board L and does not bind in this or the plate C. You will note that plate C is insulated from the rod G by a fiber bushing.



The board L is fastened to the 2x2 stakes K by the strings M which are passed through holes in the board several times and around the stakes so that they may be tied securely.

In fastening the strings to the plate C be sure that they pull evenly so that it will not bind on the rod G. You will find that the plate C will not stay parallel to B; but this makes no difference so that any part of the plate makes contact with B. In the Savannah races the pull on the wire was about 1/8 to 3/16 inch, when the wire was 2 inches high in the center of the roadway and about 7 inches high on the sides, with the span about 30 feet. From a standing start where the rear wheels are liable to lose traction it will be better to use sash cord in place of the piano wire, as the steel buttons on the tires will tear out the wire on account of catching it on the buttons.

Operating the Timer.

In Plate 2, we see the machine set up ready to time the cars. Watch No. 1 is under the starting arm, operated by the ground apparatus at the starting line. As soon as contact is made at the starting line by a car passing over, the current flows through the electro-magnet and trips the catch under the starting arm over the watch. This is then pressed down upon the stem of the watch by the spring and the watch starts. Now slide the watch carrying-bar over to the right, bringing watch No. 1 under the finish arm and watch No. 2 under the starting arm. You are now ready for another car to start as you will have cocked the arm as soon as the car has started the watch, and you are ready for the first car to finish. This operation requires about four seconds, so that cars running about five seconds apart may be handled successfully.

As soon as car No. 1 has finished you may slide watch No. 2 over to the finish arm, provided car No. 2 has started. If watch No. 2 is under the finish arm, you may as well cut out the switch marked S (for start) as both the watches are busy and you can take no more until you finish the cars on which the watches are working.

Do not use more nor less batteries than are shown on the wiring diagram as this arrangement works perfectly, and more might burn out your magnets.

Set the watches back to zero by pressing on the stem with your finger and place them again as shown in Plate 2.

If car No. 2 should overtake car No. 1 between your starting and finish lines, you will have to shift watch No. 2 under the finish arm first. Should a car No. 3 overtake and pass car No. 1 or 2 between your start and finish lines, you can cut out the switch F (finish) until he crosses your finish line and then immediately close the switch. This operation will require but a fraction of a second so that with cars running very close together, it is possible to get the car you are after in this manner.

Timing—The regulation of the ignition in an internal combustion engine; the regulation of parts of machinery so as to secure proper co-ordination.

Before studying the article below the reader is advised to peruse and study thoroughly the article on "Ignition," which will enable him to grasp more fully the methods and the effect of timing as dealt with here. Absolutely correct timing both of the ignition and the valve mechanism is essential if the engine is to give its full power. As regards the ignition, a serious irregularity may cause great injury through the spark occurring too early or not being synchronized in the various cylinders, and so setting up a "knock" which may injure the bearings and even break the connecting rod or crank shaft. We shall deal first with the coil and battery high tension system.

Coil and Battery High Tension.

The first point is to determine exactly the point at which the ignition should take place. It must be understood that by the word "ignition" is meant the firing and expansion, or, in simpler words, the explosion of the gas charge, and not the time of the spark itself. There is a distinct difference between the time at which the spark passes across the points of the sparking plug and the time at which the charge begins to expand.

To insure the greatest efficiency, the gas charge should begin to expand immediately the piston begins to descend, that is, theoretically, at the point where the piston comes to rest. As there is an appreciable interval of time between the time of breaking contact and the ignition of the gas, it follows that the break of contact must occur just that space of time ahead of the time when the piston comes to rest at the top of its stroke.

This time interval is exceedingly small, but we can readily measure it by distance, because the travel of the piston in the cylinder is at such a velocity that the piston moves an appreciable distance in a length of time which is hardly appreciable or capable of measurement for practical purposes.

It may be stated that for an engine running at 1,000 revolutions per minute, with a stroke of 4½ inches, and with the ordinary 4-volt battery, the spark should take place when the piston has about five-eighths of an inch to travel to the top of its stroke. That may be stated as a general truth, but so many circumstances occur to alter the conditions that it cannot be relied upon as theoretically correct, because the amount of compression, the density of the gas charge, and the state of the insulation in the coil will all affect the question.

Marking the Flywheel—To find the correct firing point, it is necessary to locate the exact position of the flywheel when the pistons in their respective cylinders are at the highest point in the firing stroke. In many cars the dead center points and the correct firing points are both marked on the periphery of the flywheel. Failing such marking, get an index pointer fixed to the dashboard, pointing to the top of the periphery of the flywheel, as in the diagram which follows. It can be made out of sheet tin. Next open the compression cocks, and, taking each cylinder in turn and beginning at the one which fires first, push an ordinary bicycle spoke through the cock until it rests on the piston head. Then turn the starting handle until, at the end of the compression stroke, the spoke rises to the maximum height, which, of course, indicates the highest point which the piston reaches in the cylinder. This should be carefully checked by holding the spoke in one hand, and with the other gently moving the flywheel backward and forward or operating the starting handle until satisfied that the highest point has been found. Then put a file mark on the flywheel at D 1 exactly opposite the spot toward which the index finger points and also nick the spoke with a knife blade held flush across the top of the compression cock. Follow the same operation with the other cylinder or cylinders, and mark the flywheel again, but with a different sign or number to distinguish it from the first mark. A very slight difference in the length of the spoke will be exaggerated in distance along the flywheel between the two marks, so that one measurement will check the other. A separate spoke should be used for each cylinder and marked for identification. This is advisable, because it often happens, through bad fitting or because the compression cocks are not all the same length, that the distance between the top of the piston and the top of the compression cock would not be the same in one cylinder as in the other, and if one spoke were used for all confusion would result.

To Find the Dead Center.—For the benefit of the beginner, we may explain more definitely how to locate the position of the piston at the dead center when it has completed the compression stroke and is about to begin the firing stroke. The following is the simplest method.

After having dropped the spoke through the compression cock, turn the starting handle until the exhaust valve is observed to open. The piston will then be about to ascend on the exhaust stroke. As the flywheel is still turned, the piston, and with it the spoke, will descend on the suction stroke, and having got to the lowest point will ascend again on the compression stroke. It is from the highest point of this stroke that the timing is calculated, for when the dead center is passed the firing stroke commences. The correct distance of the piston from the dead center when contact is broken is technically known as the "lead." This depends on the lag in the coil, the size of the engine, and the speed at which it is run, consequently an advance and retard arrangement is fitted to enable the driver to alter the timing to suit the variation in speed.

To Find the Piston "Lead"—Having found the dead center, the next operation is to locate the piston "lead"—in other words, the correct position of the piston in the cylinder when the spark lever is fully advanced. As we have already pointed out, a fair average "lead" is about ⅝ inch, and if the exact "lead" of the engine being dealt with cannot be obtained from the makers, this "lead" might be tried experimentally. With this object in view, nick the spoke exactly ⅝ inch above the dead center mark already recorded on the spoke applying to the particular cylinder under consideration. It is convenient for the purpose of seeing the mark better to black the top half of the spoke as far as the mark that denotes the lead, and leave the lower half bright. It will then be easy to distinguish at once when the piston has risen to the firing point. Having duly marked the firing point on the spoke, turn the flywheel until the index points to the dead center mark D 1 of the particular cylinder being dealt with, when the piston in this cylinder is at the top of the compression stroke. Next place the spoke through the compression cock of this cylinder, and turn the flywheel backward until the higher, or firing, nick on the spoke is just level with the top of the compression cock, and mark the flywheel at the spot F 1 to which the index then points. This will permanently locate the "lead" on the flywheel corresponding to the piston lead as marked on the spoke. The other cylinders should be similarly dealt with as indicated in the diagram; each with its own spoke.

In cases where there is no opening into the top of the cylinder through which the measuring wire or spoke can be inserted, it will be necessary to determine the piston position from underneath instead of above. For this purpose it is necessary to drill a small hole in the bottom of the crank chamber underneath each cylinder. These holes should all be drilled slightly to one side of the center line of the crank case. If when viewed from the front of the engine the flywheel rotates in a clockwise direction the holes should be drilled about an inch to the right of the center. If the flywheel revolves anti-clockwise, then the holes should be drilled one inch to the left of the center. These holes should be tapped with a screw thread, and screws fitted to close them after use and prevent leakage of the lubricant.

A long spoke can be passed up through these holes into the under side of the piston and the highest point determined and marked on the spoke. The distance of the "lead" required is then marked on the spoke above the first mark and the flywheel turned until this mark comes opposite the edge of the crank case. The dead center and "lead" are marked on the flywheel rim as described before. In this case,

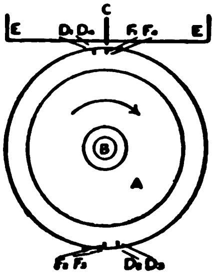


FIG. 1.
FLYWHEEL INDEX FOR FOUR-CYLINDER ENGINE.

In which the sequence of firing is 1, 2, 4, 3, beginning from the dashboard end, and in which the flywheel revolves clockwise, when looked at from the rear end. This is the case with some few engines, such as the Peugeot and Coventry Humber, but not with the majority, in which the flywheel revolves in the opposite direction.

A, Flywheel.
B, Crankshaft.
C, Index pointer fixed to dashboard.
D1, Mark on flywheel which, when exactly under index, indicates dead center point at commencement of firing stroke of first cylinder, counting from dashboard end.
D2, Dead center mark of piston for firing stroke of second cylinder.
D3, Dead center mark for cylinder firing fourth.
D4, Dead center mark for cylinder firing third.
E, E, Dashboard.
F1, Mark on flywheel, which should be exactly under index, when the spark occurs on firing stroke of No. 1 cylinder counted from dashboard. This, in the case of coil and battery system, happens when the wiper of the contact maker makes contact, and in magneto ignition at the moment when contact is broken.
F2, Index mark for timing spark in the cylinder which fires second. (Second from dashboard.)
F3, Index mark for cylinder firing fourth (third from dashboard).
F4, Index mark for cylinder firing third (fourth from dashboard).

TWO-CYLINDER ENGINES.

In the case of two-cylinder engines the flywheel marking will depend on the setting of the crankshafts. Where the cranks are set at 180 degrees the marking will be similar to that for the first two cylinders of a four-cylinder engine, that is to say, D1 and D2, with their respective F1 and F2, will be on opposite sides of the flywheel. Where the crank pins are in line with one another D1 and D2 will coincide as also will F1 and F2, but care must be taken in this setting not to confuse the exhaust stroke with the compression stroke as noted later. The latter arrangement of the crank pins is now seldom adopted. (See "Internal Combustion Engine.")

as in the other, it is necessary to use a separate spoke for each cylinder.

As an example of how flywheels are marked by the manufacturers, we may refer to the marks on the 20 H. P. Unic flywheel. It must be distinctly understood that these marks will not be the same on other engines. It is necessary that a pointer should be arranged, preferably fixed to some part of the chassis frame, and not to the body, and in such a position as to denote the dead center when the cranks are vertical. This marking is for a four-cylindered engine and sufficiently explains itself; but motorists are advised when they receive delivery of a motor vehicle or chassis to get a diagram marked out in the same way as the one illustrated to show at which times the inlet and exhaust valves of the different cylinders should open and close, and at which time

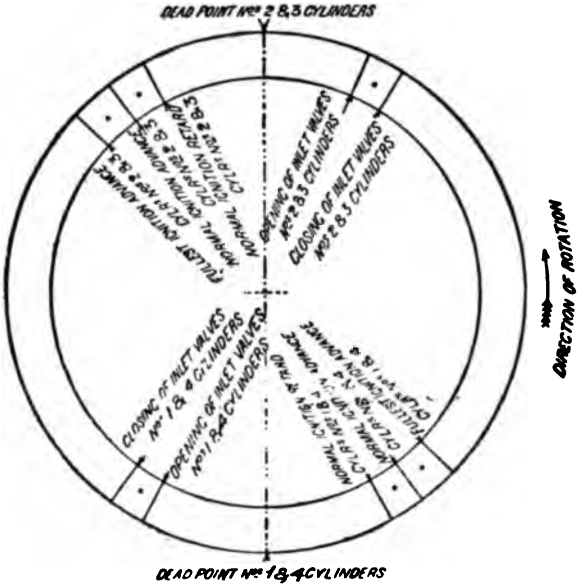

DEAD POINT Nos 2 & 3 CYLINDERS
FULLEST IGNITION ADVANCE CYL'R Nos 2 & 3
NORMAL IGNITION ADVANCE CYL'R Nos 2 & 3
NORMAL IGNITION RETARD CYL'R Nos 2 & 3
OPENING OF INLET VALVES Nos 2 & 3 CYLINDERS
CLOSING OF INLET VALVES Nos 2 & 3 CYLINDERS
CLOSING OF INLET VALVES No 1 & 4 CYLINDERS
OPENING OF INLET VALVES Nos 1 & 4 CYLINDERS
NORMAL IGNITION RETARD CYL'R Nos 1 & 4
NORMAL IGNITION ADVANCE CYL'R Nos 1 & 4
FULLEST IGNITION ADVANCE CYL'R Nos 1 & 4
DIRECTION OF ROTATION
DEAD POINT Nos 1 & 4 CYLINDERS

FIG. 2.—TIMING DIAGRAM OF A 20 H.P. FOUR-CYLINDERED UNIC ENGINE.

the ignition should take place when the ignition is fully advanced, and also to see that their flywheels are so marked from lead center to be ascertained by the spoke test). They will then be easily able to confirm or adjust their ignition and valve timing.

To Check and Correct the Piston "Lead"—If the flywheel has been already marked, but the motorist is doubtful as to the correctness of the firing, he should proceed as follows:

Turn the flywheel until at the end of the compression stroke the position of the testing spoke indicates the dead center. If the dashboard index then points to the mark on the flywheel he will know that, so far as the dead center is concerned, the markings are correct. Next measure off the correct piston "lead" on the spoke and check in a similar manner the corresponding mark on the flywheel. If the markings are incorrect, the flywheel should be re-marked.

Having now got the correct piston "lead" duly located, take the cover off the contact maker and close the circuit, seeing that the batteries are fully charged and that the plugs give a good fat spark. If the ignition is by means of a trembler coil the buzz of the trembler will indicate the time when the spark takes place, and the bright part of the spoke will be observed commencing to emerge above the cylinder head. Now, if everything is in order and the spark is advanced to the full, the buzz of the trembler or the spark on the plug ends will take place exactly as the bright part of the spoke appears. They should not occur before, otherwise premature firing will take place, causing considerably more loss of power than the same amount of late firing.

A note should be taken of the blade or wiper which connects up to each cylinder, and it should be marked with the number of the cylinder to which it opens electric communication.

The fiber plate on which the wipe contact maker is mounted, and which moves round to advance or retard the ignition, should be put forward as far as possible so that the ignition lever on the steering column will not be capable of being moved any farther. The stop should, of course, be, and generally is, on the fiber block. Now turn the crank shaft and mark carefully the point at which each cylinder fires.

The timing may be altered by pushing forward or pulling back the blades of the wiper, so that the cam or contact disk fiber segment on the two-to-one shaft meets them earlier or later, as the case may be. As a rule, it will be found to meet them late, and by filing the two holes in the blades by which they are attached to the insulated blocks on the fiber plate they may be adjusted nearer or farther away from the cam, or from the contact segment let into the revolving disk, whichever type is used. They must be nearer to the cam as it comes round if the firing is late, and farther away if it is early.

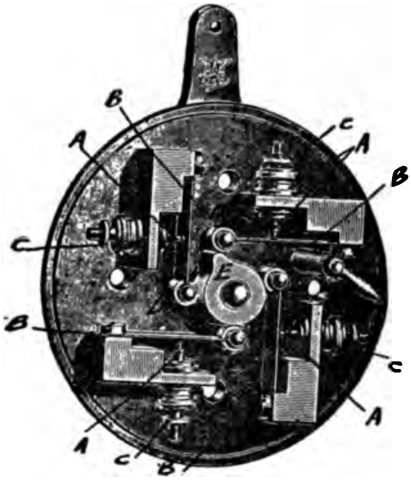


FIG. 3.—CONTACT MAKER.

It will not often be found that these wipers or blades wear unevenly, but if they do, that is the procedure. When all fire exactly as the piston reaches the predetermined point, the timing of the ignition, as far as the relative timing of the four, three or two cylinders is concerned, is correct.

In the case of a contact maker, as in Fig. 3, where a cam lifts blades which make contact with platinum pointed screws A, the blades B having platinum pieces on them, the adjustment is, of course, made by the platinum contact screws. Before making the adjustment all the platinum contact pieces on the blades and all the ends of the contact screws should be cleaned, and, if necessary, filed square across, so that the two pieces of platinum meet flat with each other.

In this type the adjustment is made by screwing the contact screw nearer the blade if the firing is too late, and screwing it farther away if the firing is too early. In each case care should be taken to see that the screws are set fast again by the lock nuts C or any equivalent device.

This is, of course, a very minute adjustment, and once made it should not be altered unless absolutely necessary.

Sometimes the length of the spring blade B carrying the roller D at its end varies from that of its neighbors. If it is too long the cam E will catch and raise it early, while if it is too short the cam may not catch it until too late. This may be remedied by filing the holes in the blade oval, as we have described in a previous case, and moving the spring blade nearer or farther away from the cam as may be required, but when this adjustment is made it is still necessary to adjust the platinum contact screw until the spark takes place at the determined time as indicated by the measuring spoke.

Other types of contact makers, and there are many of them, must be treated in the same way. They have all provision for adjustment, so that the driver may set the different contact points to meet early or late as the case may demand, but whatever the system employed the contact must be made, in the case of the trembler coil, or broken in the case of the make-and-break system, at a predetermined time in the case of each cylinder, and that time is taken from the position of the piston in the cylinder.

What we have said so far refers only, of course, to the correct timing of the different cylinders in relation to each other. Having accomplished the foregoing, any other defects in the timing of the spark which may occur through lost motion in the camshafts or the gear wheels which drive the two-to-one shaft, or in the rocking of the fiber plate on its support, or any looseness between the rods which connect the advance spark lever to the fiber plate, or any defect in the coil, will affect all cylinders equally.

Having then got all the cylinders in tune, we may proceed to rectify some other defects which may cause loss of power in this system. These defects, so far as timing goes, will cause loss of power in all cylinders equally, but any endeavor to remedy them before seeing to the timing as between contact maker and cylinder would lead to inevitable confusion.

Timing the Coil or Coils.—It has been pointed out that in timing the ignition of the various cylinders in the system which makes use of the coil and battery, it is necessary that the contact maker should make or break contact at the same relative time in all cylinders, and that so long as the same relative time is kept in all cylinders, we may depend on other means for timing the spark in all cylinders to take place at just the time when it will give the best results.

It is essential in this connection to differentiate between those systems using a separate coil for each cylinder and those using a single coil for all cylinders. It is of the former system we have so far been speaking.

Where a coil is fitted for each cylinder it is, of course, necessary to see that the time adjustment of the trembler on the coil is correct. It is not so necessary to have a high rate of vibration of the trembler in this case, but it is necessary that the trembler on the coil should respond at once as soon as the contact maker opens up the connection with the primary circuit.

If there is any appreciable lag between the making of contact by the contact maker and the buzzing of the coil to which it is attached it may be through the trembler blade of the coil being adjusted too far away from the central soft wire core of the coil, and the remedy is to set the blade so that it is normally nearer the core, and yet not too much pressed upon by the contact screw. As a general rule the trembler blade should rest one-eighth of an inch, and not more, away from the end of the core of the coil. When in this position it should just make contact with the contact screw, and when one-sixteenth of an inch away from the core of the coil it should break contact. The speed of vibration is dependent on the length of the trembler blade and its caliber, and this cannot well be adjusted by the user. These measurements are only approximate. See Coil; Trembler.

If the trembler blade is adjusted too far away from the core and bears too heavily against the contact screw, some appreciable length of time may elapse before the primary current induces sufficient magnetic pull in the core to pull the trembler for the first time toward it, and it must be remembered that it is only when the trembler breaks contact with the contact screw that the first spark passes across the sparking plug points.

It is necessary, therefore, to see that all the trembler blades on the different coils act as quickly as possible, and as nearly as possible with the same interval of time after the making of contact. This can be easily tested by attaching a piece of wire to the metal segment in the contact maker (in the case of a wipe contact) and touching in turn each of the wipers, noting by ear the quickness or slowness of the trembler to respond to the contact. The ear alone can be relied upon for this adjustment, and each trembler should be adjusted so that it responds to the contact as quickly as, and not more quickly than, its neighbor.

When making this adjustment it is advisable that the coils and batteries should be in position in the car. The indicating marks which it is advisable to put on the different contact making blades should refer to the coils equally with the cylinders, so that the coils may be identified in sets with the cylinders they fire and the contact makers which operate them.

When making this adjustment with the style of contact maker which uses a cam and raises a spring blade which ashes. It is not advisable, however, for the motorist to interfere with the coil at all, with the exception of the adjustment of the trembler.

Sometimes a coil trembler will prove sluggish owing to a short circuit somewhere in the winding—generally in the low tension or primary wire. Such short circuit is generally caused by loading the coil with a current of too great a voltage, which may happen through two or more batteries being coupled up in series instead of in parallel. This primary current induces one of so much higher tension that it may heat the wires until the insulation is destroyed, when two adjacent windings may come into contact with each other and a short circuit occur. Such troubles can only be remedied by rewinding the coil—a task quite impossible for the amateur. When coils are damaged in this way they should be returned to the makers, and often it will cost nearly as much to rewind one as the purchase of a new coil. See "Coil" in Repairs and Adjustments.

It should be thoroughly understood that for the purpose of timing the coils it is not advisable to meddle with anything other than the adjustment of the trembler blade, and that any defect in the coil can only be remedied by a new coil or the repair of the old coil by a competent repairer. What is essential is to get the first make-and-break of the trembler of the coil to take place immediately the contact is made by the contact maker, and if this has been adjusted in accordance with the instructions already given, then all the cylinders will fire at the same time relatively to their piston stroke and to each other.

Synchronized Ignition using a Single Coil.—This question of the timing of coil tremblers is so important that most firms now use synchronized ignition. The Napier is an instance of this. The usual contact maker is fitted, making as many contacts per two revolutions of the engine as there are cylinders to be fired. This contact maker opens up, each time, communication through the primary winding of a single trembler coil, so that on each piston coming into the firing position a series of sparks will pass across all the sparking plugs, which are all in circuit in the high tension windings of the coil.

Now, in order to utilize but one sparking plug at a time, and only that which fires the cylinder which for the time being is ready to be fired, it is necessary to supply a distributer in the high tension circuit. This distributer is another form of wipe contact maker, only that instead of dealing with the primary or low tension current it deals with the high tension current, and that from only one coil; an intermittent current being delivered through the trembler make-and-break. This system gets over all the trouble of synchronizing the several coils so as to give equal timing in all cylinders, and is being very generally adopted, not only with battery ignition, but also with high tension magneto ignition. The distributer, once set, will fire all cylinders at exactly the right time, and will prevent any loss of power through incorrect timing or sparking of the cylinders relatively to each other. The Napier system is illustrated under Ignition. Also see Contact Maker.

The Most Effective Firing Point.—We have described how to get all cylinders synchronized, so that they will all fire at the same point in their piston travel. It now remains to determine the exact time at which the ignition should take place in all the cylinders in order to get the highest power out of the fuel used.

This point of ignition depends to a great extent on other and extraneous circumstances. When running the engine at a very high speed it is found that the piston travels so fast that the limit of time allowed for the ignition of the charge and for the current to pass through the primary winding, excite the secondary current and start the trembler vibrating, is so very small that the ignition has to take place some distance before the piston reaches the top of the compression stroke. The speed of the engine, the nature of the gas mixture, and the length of stroke compared with bore, as well as the amount of compression obtained, and the intensity of the spark, are all factors in fixing the earliest point at which the ignition should take place.

As a general rule, it may be said that the make or break of the current—as the case may be—should take place when, with ignition fully advanced, the piston is about five-eighths of an inch from the top of its stroke. As a matter of actual fact, when the engine is running fast, with this allowance for piston lead, ignition of the charge takes place on the dead point which is the desideratum for efficient combustion.

It will be understood that when the sparking is advanced too much the charge will be fired on the top of the up-coming piston, which will cause a tremendous knock in the engine, easily heard, and sometimes felt by the experienced driver. When starting, of course, the ignition is always retarded, because the engine is then running so slowly that there is ample time for the spark to be produced after the contact maker has connected up the primary circuit.

Some manufacturers arrange for the advance and retard of the contact maker being varied by the driver within very wide limits, and thus leave it open for him to advance the spark to such an extent as will cause knock, due to premature or back firing. Though the engine cannot actually be reversed when running at high speed with the full load of the car on it, a most dangerous strain may be put on the engine mechanism and the transmission system generally.

It is advisable, therefore, to arrange so that when the position of the sparking lever on the steering wheel is determined, the engine shall be running at its maximum speed, it shall have a full load on, and shall be taking the best possible mixture. These conditions are only to be obtained in actual running on the road, unless the user has some means of applying a load by means of a brake on the engine flywheel. The best way, therefore, is to get the car running on a long, straight stretch of road, preferably with a very slight down gradient, put in the top speed with the accelerator in action, if one is fitted, and then gradually advance the ignition, carefully listening to the engine. The moment the slightest sign of a knock is noticed it can be taken for granted that the ignition has been advanced too far and is taking place too early. The lever should then be moved back very slightly, so as to stop the knocking, and with the car traveling at full speed, and the engine working quite smoothly, the position of the spark lever can be noted for future reference. It should be understood that the position of this lever on the steering column, relatively to the position of the contact maker plate, can only be altered by some alteration in the joints or in the rods which convey the motion from it to the contact maker plate. It is advisable that it be so adjusted that the lever cannot be operated too far, or farther than necessary to advance the ignition without causing it to take place too early. In most cases the stop is on the plate of the contact maker, but in all cases it should be so adjusted that the lever cannot be moved too far.

If this adjustment is properly made, the driver will be able to get the highest power out of his engine, but, of course, the spark should always be retarded when starting, when the engine is running slowly, or when it is laboring on a hill. The latter for the reason that when the engine begins to labor and run slow, if the ignition is not retarded it may possibly fire on the upcoming piston and cause a "knock" and its resulting strains. As soon, however, as a change of gear is effected, the ignition should be again advanced. See Driving.

Timing the Valves.

We shall now deal with the timing of the valves in an internal combustion engine, and some defects which may cause loss of power. Generally speaking, not much can go wrong with the engine to put the valves out of time. The most usual defect is due to wear, and this wear may occur in a number of places and cause combined errors which will make one big error sufficient to put the valves out of time. For instance, suppose that the cams on the valve shaft and the ends of the tappet rods or valve plungers were to wear excessively, then the lift of the valve would be sensibly diminished. The same defect would result if, through the constant hammering of the plunger or tappet rod, the end of the valve spindle were slightly flattened out, or the end of the plunger. Both these defects will cause the valve not only to lift too late, but also to close too early, and will also result in the valve not opening high enough to give the full area for the gas to flow through. These remarks apply equally to the inlet valves, where these are mechanically operated, and in this case the defect would probably cause more loss of power than the same amount of wear in the exhaust valve mechanism. The surest way to detect excessive wear in these parts is to examine the space which exists between the bottom of the valve stem and the top of the plunger rod or tappet rod. When the valve is down on its seat and the shaft is turned so that the plunger is on the lowest part of the cam, there should be sufficient space to insert an ordinary visiting card, and not more. Too much space here shows wear, and too much space also sets up excessive hammering between the plunger and the valve stem, beating the metal down and aggravating the trouble.

This defect may be remedied in modern motor cars by readjusting the adjustable plungers, so that when the valve is on its seat there is just the thickness of a visiting card between the bottom of its stem and the top of the plunger when the engine is hot. If the plungers are not adjustable, it may become necessary to alter the length between the valve face and the bottom of the valve stem, which can be done by turning the valve head in the lathe. See "Valves" in Repairs and Adjustments.

Other causes of improper timing of the valves may be radical injury to or misplacement of the gears which transmit the motion from the engine crankshaft to the camshaft. If there is excessive wear on the teeth of the gear wheels, or if any of the wheels get loose on their shafts through any cause, then a certain amount of backlash or lost motion is set up, and this makes the whole of the operations of the cams slightly later than they ought to be in relation to the position of the piston in the cylinder. These defects cannot be remedied by the user except, perhaps, in the case of loose keys, when the obvious remedy is to take out the keys and fit new ones. This, however, is an expert fitter's job, and wants careful doing, as the wear in the key-ways will necessitate the latter being enlarged and bigger keys fitted. Wear on the teeth, which in good engines can only take place after much use, can only be remedied by a new pinion or gear wheel. With big gear wheels, such as are now fitted on all high class cars, the amount of wear which would take place would make an almost inappreciable difference to the timing, as the amount of movement on the camshaft would be so very slight.

In case of an accident, such as a broken crankshaft, the camshaft may get twisted round, and this might result in one set of cams being later or earlier than the other, as the case may be.

Sometimes, when a car has been dismantled, and the engine taken down for any repair, it happens that the parts are reassembled with the wheels meshing with each other in the wrong teeth. In every pair of gears a tooth in one wheel and a space between two teeth in the other should be marked with a center punch, and this should be done as soon as it is found that the timing is correct. If the user, for any purpose, disengages these gears, he should see beforehand that two such marks exist. If they do not, he should himself make them before he takes the gears apart from each other, marking them on the sides of the teeth, so that the marks come exactly together; one on the tooth and one against the space is the best way. See Overhauling.

The cams operating the valve plungers are generally in one piece with the camshaft, being machined out of solid steel. There is thus no possibility of loss of power owing to their getting shifted round on the shaft.

Where automatic inlet valves are used, there is no mechanical timing for them. Nevertheless, the time at which they open can be regulated by the adjustment of the springs which keep them normally on their seats. The stronger the tension on this spring the later will the valve open, for the piston will have to descend appreciably before the difference in pressure between the gas inside the cylinder and the atmosphere outside it is sufficient to open the valve. As long as the tension on this spring is sufficient to keep the valve closed, and to close it quickly on the commencement of the compression stroke, that is all that is required. Any pressure above that which is necessary for this purpose will cause loss of power. Automatically operated valves will now only be found in motorcycle engines or in examples of the earlier cars. See "Valves" in Repairs and Adjustments.

The timing of the exhaust valves may be affected by weak springs. When these get weakened through heat, or through fatigue, they should be at once renewed.

In the full-page diagram herewith we have given the average lead for the inlet and exhaust valves, calculated from a number of well-known engines. These cannot, of course, be taken as absolutely correct for any particular engine, but it may be taken for granted that if the user does not know actually the timing adopted by the manufacturer, and he times his engine according to this diagram, he will get good average results.

The actual timing of the engine in the well-known Mercedes car may be given as an example. It is as follows:

Inlet Valve Opens—When piston has traveled 1 mm. after the closing of exhaust valve.

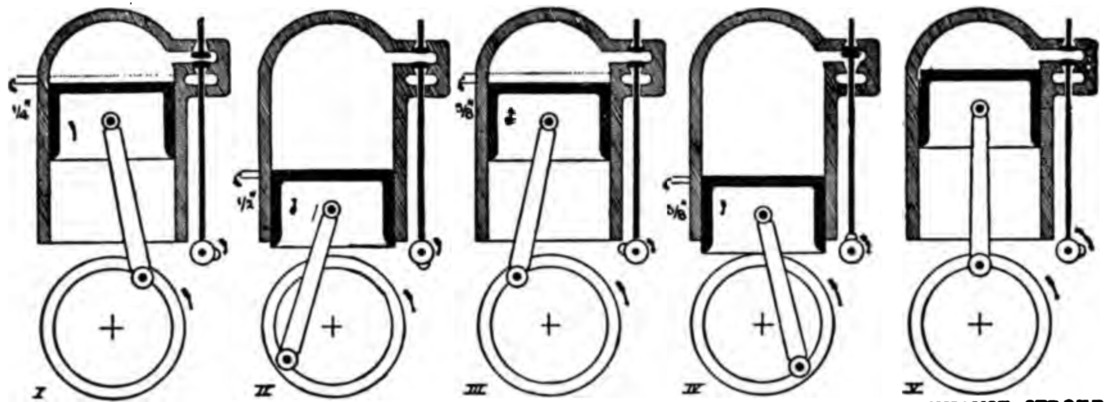
Inlet Valve Closes—When piston has turned dead center from bottom of suction stroke.

Exhaust Valve Opens—When piston is 25 mm. from the bottom on power stroke.

Exhaust Valve Closes—When the piston is just over the dead center at beginning of suction stroke.

Magneto Ignition—Low Tension System.

In the low tension system of magneto ignition the "lead" should be much less than when the spark is produced by coil and battery, because in the first place the spark occurs prac-



SUCTION STROKE. Inlet valve *opens* ¼in. *after* piston has started to descend.

COMPRESSION STROKE. Inlet valve *closes* ½in. *after* piston has commenced to ascend.

COMPRESSION STROKE Spark contact is made ⅜in. *before* piston has reached dead center, with ignition fully advanced, after which downward power stroke takes place.

EXHAUST STROKE. Exhaust valve *opens* ⅝ in. *before* piston commences to ascend.

EXHAUST STROKE. Exhaust valve *closes* when piston has reached the dead center.

The dotted lines in all cases denote the dead center at each end of the stroke.

The times of opening and closing the inlet valves only refer to those valves which are mechanically operated.

In this diagram the positions of the piston are shown at the time when the inlet valve opens, when it closes, when the sparking should take place, the exhaust valve opens, and when it closes. Different makers adopt different timings, but above is about the average of 14 well-known makers.

The timing of the spark contact refers only to high tension ignition. When the contact is broken inside the cylinder, as in the low tension magneto system, it should be broken almost immediately on the dead center.

N.B.—This diagram shows automatically operated inlet valves. The timing will be the same with mechanically operated inlet valves.

tically instantaneously with the break of contact in the cylinder, there being no induction coil to produce a "lag," and in the second place the spark is more in the nature of a flame,

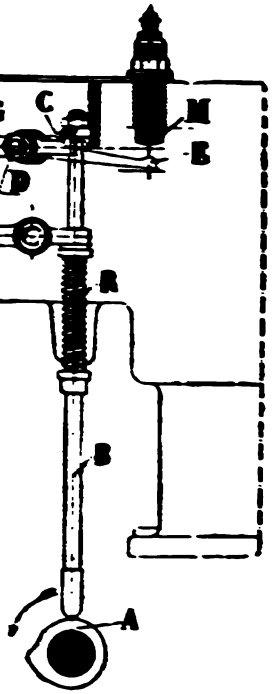


FIG. 5—THE PEUGEOT CONTACT-BREAKING MECHANISM

A. Cam or valve shaft actuating tappet rod B.
B. Tappet rod; sometimes called the Trip Rod.
C. Interrupter Catch; sometimes called the Tappet.
D. Rocking lever shaft.
E. Contact arm inside the cylinder; sometimes called the Interrupter.
G. Arm of striker, to which spring is attached. The other arm against which C acts is generally referred to as the Striker, or the Interrupter Arm.
M. Igniter plug inside cylinder; sometimes called the Insulated Pin.
R. Spring for keeping B in firm contact with A.

and hence produces more rapid and more complete combustion. In fact, in some types of engines there is no "lead" given, the spark occurring when the piston is at the dead center after the compression stroke. A very slight difference in the time at which the break occurs in the various cylinders will cause considerable variation in sparking, with consequent loss of power and balance, and to get the correct adjustment, therefore, is a delicate operation.

Before proceeding further, we should recommend the reader to carefully study the illustration of a simple make-and-break system under Ignition, with the descriptive matter relating thereto, and also the illustration of the F. I. A. T. system in the same article.

There are variations in detail among the different systems, but the principle is the same. Consequently, if we take for our purpose the mechanism as fitted to the Peugeot engine it will prove a sufficient guide to the intelligent reader, even if the system he is using may differ slightly.

In Fig. 5 it will be noticed that the interrupter catch or stop C is on the top of the tappet rod B. The action is as follows: The cam A, which is fixed on the half-speed shaft, acts on the lower end of the tappet rod B. This rod is normally kept in contact with A by means of the spring R. As long as the rod B is in contact with the circular portion of A, the interrupter catch or stop C pressing against one arm of the striker G keeps the contact arm E, which is inside the cylinder, and is consequently shown in dotted lines, from contact with the igniter plug M. When, however, the projecting part of the cam A raises the tappet rod B the interrupter catch or stop C is raised off the end of the small arm of the striker G. The action of the spring on the other arm of G then brings the end of the contact lever E in contact with M. The circuit is then completed, and when the tappet rod B suddenly leaves the projection on the cam the break thus caused in the circuit between E and M produces the spark, which ignites the charge.

Now, wear may take place at the following points, but more especially the last three: The cam A, the lower end of the tappet rod B, the interrupter catch C, the end of the striker against which it bears, the contact lever E, and the igniter plug M. This wear will alter the exact period at which the contact between the contact lever and the igniter plug is broken, and so affect the timing.

An engine such as the two-cylinder 10-12 H. P. Peugeot gives its best results at about 850 revolutions per minute, and consequently it requires a very slight "lead." After careful experimenting on a pattern in which no provision was made for advancing the ignition, it was found that a 1-64 inch lead gave smooth running, and on trying the car on a test hill it took five adults up on the high speed, which surpassed its best performance when new. In most cars, however, the break of contact between arm and igniter plug should, with the ignition advanced, be timed to take place considerably earlier.

We will now suppose that the reader has a similar car to the 10-12 H. P. Peugeot, which is of typical construction, and wishes to adjust the timing for a lead of 1-64 inch, or, in other words, regulate the break of contact in each cylinder to take place when the piston is within 1-64 inch of the highest point on the compression stroke. The following is the modus operandi:

Having located the position of the piston at the dead center, as already described in connection with the coil and battery system, measure off 1-64 inch above the dead center point on the spoke, and place a second nick at the point so measured off. Then turn the flywheel until the index points to the dead center mark D1 (see Fig. 1) of the particular cylinder being dealt with, when the piston in this cylinder is at the top of the compression stroke. Next place the spoke through the compression cock of the cylinder, and turn the flywheel backward until the higher or firing nick on the spoke is just level with the top of the compression cock, and mark the flywheel, unless this has already been done, at the spot F1, to which the index then points. This will permanently locate the "lead" on the flywheel corresponding to the piston "lead" as marked on the spoke.

Having thus found the correct position, the operator should turn the starting handle until the tappet rod B (Fig. 5) is at the highest point, and should then slack the striker G on the tapered part of the rocking shaft D, so that each is free to move independently of the other. The spring should be removed, and, holding the end of the contact lever shaft D, it should be turned to the left until the internal arm E is felt to be making firm contact with the igniter M. The striker G, on which the interrupter catch C acts, should then be pushed home on the rocking shaft D, without altering the ends vertically, and secured by the lock nut.

The critical part of the adjustment has now to follow. It consists of regulating the height of the interrupter catch C on the tappet rod so that when the tappet rod is at its highest point C will not be in contact with the end of the striker G. This means that the end of E will then, under the action of the tension spring, be in firm contact with M. The space between C and the end of the striker should be just sufficient to insure that they come into contact at the very moment that the index on the dashboard points to F1 on the flywheel. In other words, that the break between E and M takes place when the piston is within 1-64 inch of the top of the compression stroke, or, in other engines, at the distance recommended by the manufacturers.

This adjustment is a delicate one, and when necessary to effect may take some little time. The simplest way is to place a piece of very thin paper between C and the striker. Then turn the flywheel until the index (see Fig. 1) points to the letter on same referring to the particular cylinder being dealt with. At this stage the paper should be just held between the two surfaces against a gentle pull, and no more. In other words, the break between E and M is just about to commence.

The pressure should not be sufficient to depress the striker against the action of the spring, even to the slightest extent. The lock nut should then be screwed home. Should the threads fit loosely it may be necessary to slack back C about one-quarter turn, as the locking down of the lock nut may depress it on the rod too far. The same operation should be followed for the other cylinder. If the necessary delicacy and care has been observed in marking the flywheel and carrying out these instructions, both cylinders will then be exactly similarly timed.

It must be borne in mind, however, that it is not sufficient, to insure the best results, that the break in the cylinder occurs at the correct moment. The amount of break is also a factor in the proper running of the engine. If the space between the interrupter catch and the striker at the highest point of the tappet rod is too great the break in the cylinder may be infinitesimal. If, on the other hand, the space is very small, the break will be too great, leading to excessive hammering between the contact lever and plug, and indifferent sparking, while in extreme cases the contact lever may even strike the cylinder. The movement of the striker should be only just appreciable when the engine is running.

The timing of a four-cylinder car should be effected on the same lines with the aid of Fig. 1.

It is necessary to remember always that the magneto gives the highest voltage of current when the edge of the rotating armature is just leaving the edge of the magneto field piece, and this should be the position when the contact is broken inside the cylinder. The only adjustment for this is to alter the relative position of the armature sleeve shaft of the magneto with the engine or valve shaft. This is hardly an adjustment which the amateur mechanic can satisfactorily carry out.

In some types of low tension contact breakers or igniters the contact arm is drawn away from the insulated igniter plug by the sudden releasing of a spring due to the tappet dropping into a recess in the cam. In such cases it is necessary to see that the contact arm or its equivalent is free and is held up to the insulated plug just before the time of breaking contact, and the amount of slackness which is allowed between the descending tappet and the arm should be the same in all cylinders.

Most cars are supplied with an index on the dashboard and the proper marks on the flywheel. It must be borne in mind, however, that any wear in the connecting rod brasses will alter the relative position of the flywheel to the index when the timing is best tested, and consequently it will be impossible to make the adjustment with the delicacy that is required until the bearings have been adjusted. It must also be remembered that in different sized engines, or engines running at different speeds, the position of the piston, when (to give the best results) the spark should occur, varies considerably.

We would, therefore, impress the following points on the owner:

1. When the car is received new from the makers with the flywheel marked, he should place the flywheel so that the index points to the dead center mark D1 (Fig. 1), and then putting a spoke through the compression cock, nick it as already described. He should next turn the flywheel until the index points to the ignition mark F1, and should again nick the spoke. He has now got the exact position of the piston at which ignition should take place, and should keep the spoke for future reference, so that when adjusting the timing he can check the flywheel marks by means of the piston position, as shown by the spoke. A separate spoke should be kept for each cylinder, as before explained. If he finds, after use, that they do not agree, he may conclude that the connecting rod brasses are worn or need adjustment, and should have them seen to at once.

2. If on so testing, in the first instance, he finds that the piston positions in the respective cylinders do not agree, he may conclude that they are timed wrongly in respect to each other. He should then find out from the makers of the car the exact correct distance between the firing point and dead center, in millimeters or fractions of an inch, and, having marked a spoke accordingly, should alter the flywheel markings to correspond. Of course if, when in the first instance the dead center point is being marked on the spoke it does not correspond with the index mark on the flywheel, it can at once be concluded that the flywheel markings are wrong. When the index pointer is fixed on the dashboard it may happen that through collision or other cause the dash may be thrown over to one side. It is well, therefore, to measure from the inside

of either side of the chassis frame to the index pointer, marking its distance on either side. It can then be ascertained at any time if the index pointer has moved relatively to the engine crankshaft. Sometimes instead of altering all the marks on the flywheel an adjustment of the index laterally may put all right.

3. If a car has not been indexed and marked by the makers, and if the owner has omitted to do so when it was new, wear or looseness in the connecting rod bearings will upset his calculations. He should therefore first examine his connecting rod bearings to see if they are correct. If they are not, he should have them put right. He should then write to the makers for the correct firing position of the piston in the cylinder, and having himself taken the dead center position on the spoke, should carefully measure off the distance in fractions of an inch or millimeters (25 mm. equal 1 inch) as given him by the makers. The spoke having been correctly marked, he can now fix an index pointer on the dashboard, and mark the flywheel accordingly for timing purposes.

The igniter plug and the end of the striker arm get worn in process of time by the constant hammering, so that good contact is not made. They should be filed smooth, and then the timing readjusted. When either the igniter or striker, or both, get excessively worn they should be replaced.

The method of actuating the striker varies in different cars, and the fullest details should be procured on purchasing, together with particulars as to the method of adjustment. The principle, however, is the same in all.

The F. I. A. T. or Fiat is an example of a good system of low tension magneto ignition. It is described and illustrated under Ignition. In this the end of the tappet rod acts directly on the striker, and the adjustment of the latter on the rocking shaft is much the same as in the case of the Peugeot, described above. The contact arm, however, bears against the center stem of the igniter instead of the end, and this stem can be revolved when one portion gets worn and upsets the timing.

The High Tension Magneto System.

The high-tension magneto is the system of ignition now most largely adopted.

There are several different types of high tension magneto machines in use. Some of these are arranged to give a high tension current without the use of an outside separate coil, while others generate a low tension current, which is then passed through a separate induction coil which induces a high tension current.

The Bosch or Simms high tension magneto, in which the induction of the high tension current is obtained direct in the winding of the armature, is so arranged that there is no necessity for any adjustment of the timing, which is fixed and cannot be deranged, both contact maker and distributer being operated from one disk on the single shaft. The moment when the advance and retard lever K (see Ignition, Fig. 19) is at its most advanced position and the contact points break contact, is the time at which the piston should be in the position which will give it the required "lead," as explained earlier.

The machine itself consists of a magneto somewhat similar to that used with the low tension system of ignition, but in the low tension magneto there is only one winding on the armature (a low tension), whereas in the case of the high tension there are two windings. One of these (the low tension) consists of a few turns of thick wire, and the other (the high tension) a large number of turns of very fine wire. The current generated in the low tension winding induces a high tension current in the high tension winding; in fact, the armature may be considered a rotating induction coil. In some of the machines the armature does not rotate, but a rotating shield is used, as in some of the low tension machines. If a rotating shield is used, the machine (in the case of a four-cylinder engine) is run at camshaft speed, but if the armature rotates, it is run at the same speed as the engine.

The other essential parts of the machine are the low tension contact breaker, which is arranged to break contact just as the armature has passed the maximum position, and the high tension distributer which distributes the high tension current to the respective spark plugs in proper rotation.

In the case of the rotating armature type of machine the distributer is mounted on the magneto and driven by a gear wheel keyed on the same shaft as the armature. It is obvious that, these gears being properly meshed, the correct timing of the distributer relative to the armature is insured. If for any purpose the magneto is dismantled it is necessary that the shaft carrying the armature and the shaft carrying the high tension distributer should be so assembled again that the distributer wiper makes contact just at the moment that the low tension contact breaker breaks contact.

In some cars the high tension distributer is fitted entirely independently of the magneto itself. When this is done the current is simply taken from the magneto to the distributer by means of a high tension cable.

The Eisemann magneto is an example of the machine generating a low tension current and passing it through a separate coil to induce a high tension current. This machine is fitted with contact breaker and distributer as described in the former type.

In the magneto system, whether high or low, the magneto machine is geared to the engine by some positive form of drive, generally by gear wheels, but sometimes by a chain. If the machine is fitted with fixed armature and rotating shield, it is driven at half the speed of the crankshaft. If, as is more often the case, the machine is fitted with rotating armature, it is then driven at the same speed as the crankshaft. If for any reason the magneto machine is disconnected from the engine, it will be necessary when replacing it to see that it is so timed that the contact breaker breaks contact when the piston of engine is in the correct position for firing, and also that the distributer brush of the high tension distributer is making contact with the terminal connected to the correct cylinder.

The best and obvious plan in dismantling the appliance is to mark with a center punch the adjacent teeth of the gear wheels in mesh, and at the same time mark which contact of the high tension distributer is in contact with the brush. This is important as, the distributer being geared to run at half the speed of the armature shaft, it will be quite evident that the brush will have two different positions to correspond with the same position of the armature shaft. It sometimes happens, however, that the magneto has to be assembled when there are no marks on the wheels. To guide the assembler, the following method is then adopted:

Turn the engine until one of the pistons is in the determined firing position, as indicated by the index pointer against the flywheel, as already described. Then turn the magneto shaft into the position where the contact breaker has just broken contact. This is the time for firing. There will be a difficulty in holding the magneto armature in exactly this position owing to the pull of the permanent magnets on the armature. It can generally be wedged in some manner, and it should be so wedged that the armature cannot be moved and remains in the position we have indicated. With the engine, then, in the correct firing position and the magneto wedged in the contact-breaking position, the whole appliance should be moved sideways on its base into mesh with the wheel which drives it, and then firmly coupled up. In the case of the chain drive the chain can be simply slipped on.

Care of the Magneto.

Always see that the magneto is kept clean and free from superfluous oil. The machine itself should only require a few drops of oil every week.

See that the platinum contacts of contact breaker are kept clean. If from any cause they should get dirty and pitted, they should be carefully filed up and adjusted so as to give a break of somewhat less than half a millimeter.

Keep the high tension distributer clean and free from dust and oil. Do not put oil on the distributer.

If the magneto should fail to work, examine and see if the contact breaker is breaking contact properly. If it is not, the trouble may be due to the small rocking arm carrying contact not working freely on its pivot, or it may be due to one of the rollers which this lever strikes against not revolving freely. If both these are correct, the remedy is to readjust the contact screw. If the contact breaker is working correctly and still no current can be got from the machine, unscrew the high tension terminal at the opposite end of the armature, and see if the small carbon brush inside of same is making proper contact on the collector ring of armature. Also remove any carbon deposit resulting from the contact between the brush and collector ring.

Timing Gear and Half-Speed Shaft.—The timing gear of the engine consists of the system of shafts and cams which regulates the time at which the spark occurs in the cylinder, and also the correct opening and closing of the exhaust and inlet valves.

The timing gear and half-speed or two-to-one shaft are used to operate the valves and contact maker or breaker. To complete the Otto cycle the piston traverses the cylinder four times. During the first the inlet valve is open to admit the charge, during the next compression takes place, during the third the charge is ignited, while in the fourth the exhaust valve opens, and the cylinder is cleared of the spent gases. The consequence is that the valves and spark only require to be operated once in every four piston strokes or two revolutions of the engine crankshaft.

To attain this, a shaft, traveling at half the speed of the crankshaft, is provided, on which are mounted the cams operating the valves and the contact maker or breaker. To revolve this shaft at half the speed of the crankshaft two or more gear wheels are employed, one—that on the crankshaft—being half the diameter of the one on the cam shaft. See Internal Combustion Engine.

It is obvious that the same relative position of the cams and piston must always be maintained. The easiest method in which to make any difference in this position is to loosen one gear wheel and turn it either to the left or right (if the valves do not open at the right time), thus engaging a different tooth in the other gear wheel, and giving the valve a "lead" or "lag" of its former position, according to the direction in which the gear wheel is turned.

Note that any alteration in the setting of the half-speed shaft on which the contact maker is fixed will affect the firing, and, should this have been correct before the change, it will have to be readjusted to suit the altered position of the shaft. See Timing, above.

Timing Ignition—See Timing above; also Valve-setting.

Timing, Multi-cylinder—See under Ignition; Timing.

Timken Roller Bearings—These bearings are much used in modern motor-car axle construction. See Axle.

Tin—A metal of white, brilliant color, slightly tinged with gray. It is hard and malleable, occurs mostly as an oxid, and is not very abundant. Used mostly in coating other metals, especially iron in the manufacture of tin-plate. Also valuable in alloys and solders.

Tin, Block—Tin cast into blocks ready for commercial use.

Tin-foil—Pure tin or tin alloyed with a little lead, beaten and rolled into thin sheets.

Tin-plate—Thin sheet-iron coated with tin.

Tin, Salt of—Tin dissolved in hydrochloric acid, used as a mordant.

Tin Spirits—Solutions of tin used in soldering, etc. Nitric acid, sulphuric acid and hydrochloric acid are used in their preparation.

Tip—An end piece or extremity, as of a gas-burner; a nozzle.

Tire—A band, hoop or circular tube attached to the periphery or circumference of the wheel of a vehicle. In the case of horse-drawn vehicles, commonly of wood or iron, for the purpose of binding the felloes and securing the rim of wheel from wearing or breaking; sometimes of solid rubber to ease the jar or shock of the vehicle, at the same time increasing the tractive adherence.

In the case of motor vehicles, the tire used is either of solid rubber or a "pneumatic tire," that is, an inflated rubber tube incased in a circular casing of more durable material which takes the wear and tear of travel.—See Tires below.

Tire Attachment—See under Tires.

Tire Band—A band for the protection of a tire or any injured portion of the casing.

Tire Bolt—One of the bolts by which the casing of a pneumatic tire is attached to the rim. Tire bolts have a rounded head and are secured in place by a wing nut. Also called security bolts.

Tire Brake—A brake which acts directly upon a tire.

Tire Burst—See "Tires" in Repairs and Adjustments.

Tire Casing—The outer cover of a pneumatic tire.

Tire, Cellular—A form of so-called solid tire having longitudinal cells or tubular hollows and more properly called a cushion tire.

Tire, Clincher—A pneumatic tire held in position on the rim of a wheel by means of projections fitting into flanges on the rim, or by the pressure of the air when the tire is pumped up.

Tire Cover—A case for spare tires, made of leather, canvas, rubber, etc., and carried on the car. Often attached to the body and footboard by means of irons. The term cover is also applied to the outer casing of a pneumatic tire.

Tire, Cushion—See Tire, Cellular.

Tire, Driving home with Burst—See "Tires" in Repairs and Adjustments; Driving, etc.

Tire Expense—See "Luck and the Tire Bill" under Driving.

Tire Gaiter—A sleeve for protecting an injured tire.

Tire Hints, Miscellaneous—See Tires and Wheels.

Tire, Leather—Many experiments have been made with leather as a material for both solid and pneumatic tires for motor cars and with considerable success. The difficulty has been to prepare leather so as to be as nearly as possible waterproof and in what is known as chrome leather this quality has been practically secured. Leather is much used as casing for rubber tires.

Tire Levers—See "Tires" in Repairs and Adjustments.

Tire Patching—See under Care and Maintenance.

Tire, Pneumatic—See Tires, below.

Tire Pump—An air pump for the inflation of pneumatic tires. See Tools, Spare Parts and Accessories.

Tire Punctures, Repairing—See "Tires," in Repairs and Adjustments.

Tire Repairing Outfit—See Care of a Car on Tour; Repairs and Adjustments.

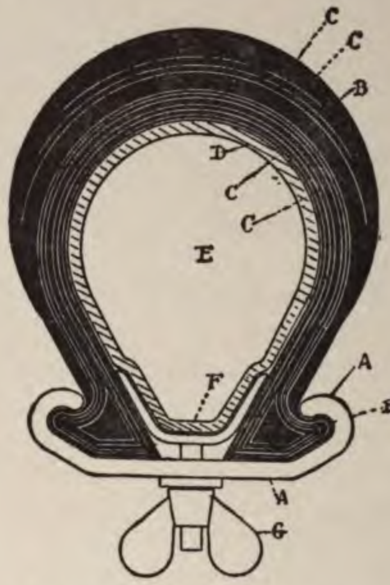
Tire Repairs—See under Tires; also Repairs and Adjustments.

Tire Repairs, Vulcanized—See under Care and Maintenance; also Repairs and Adjustments.

Tire Rim—See Rims.

Tires—The tires used on the wheels of motor vehicles may be roughly divided into three classes: solid, pneumatic and semi-pneumatic. In practically all classes, rubber is the material forming the tread or that part which has to take the wear and tear of the road. In some forms of spring wheels the ordinary iron tires may be used, but as these are only fitted on the heaviest class of motor vehicles, no further reference need be made to them here.

The Solid Tire—As its name implies, the solid tire is a band of rubber, solid, and having no inner chamber. It is so called to distinguish it from the pneumatic tire. Sometimes the solid tire is made with holes or chambers of small size, when it is more appropriately known as a cushion tire. Rubber is universally used for both kinds of solid tires, no other substance having been found which will withstand the heavy wear and weight and give the same cushioning effect. The use of solid tires on pleasure motor cars is now rare except in automobiles of the high-wheel or buggy type, which appear to be growing in popularity. See articles under Solid and Pneumatic.



A, rim.
B, outer cover.
CC, fabric insertions in B.
D, inner tube.
E, air space. F, security bolt.
G, winged nut.

Beaded Edge Type of Tire.

The Pneumatic Tire—The pneumatic tire as used on motor vehicles is constructed practically on the same principle as the bicycle tire, but, of course, it has increased size and strength, and in order to withstand the strains set up tending to drag it off the rim special means of attachment become necessary. The pneumatic tire is almost invariably built up of a combination of rubber and cotton, canvas or other fabric. The outer casing is always detachable from the rim of the wheel, and is built up of alternate layers of fabric and rubber, a very thick outside tread of rubber being left on the extreme periphery of the tire to take the wear. The whole of this outer cover is vulcanized together in course of manufacture, which prevents the fabric and rubber from becoming detached by the heat set up in this class of tire when in use. The air chamber or inner tube is a separate bag of vulcanized rubber without any fabric. It lies inside the outer cover, and is inflated with air at considerable pressure by means of a tire pump or inflater. The care and repair of tires is dealt with fully under "Tires" in Repairs and Adjustments.

The most common and simple method of attachment is the clincher principle, now used on practically all makes of automobiles. See Rims.

Non-Skid Devices.

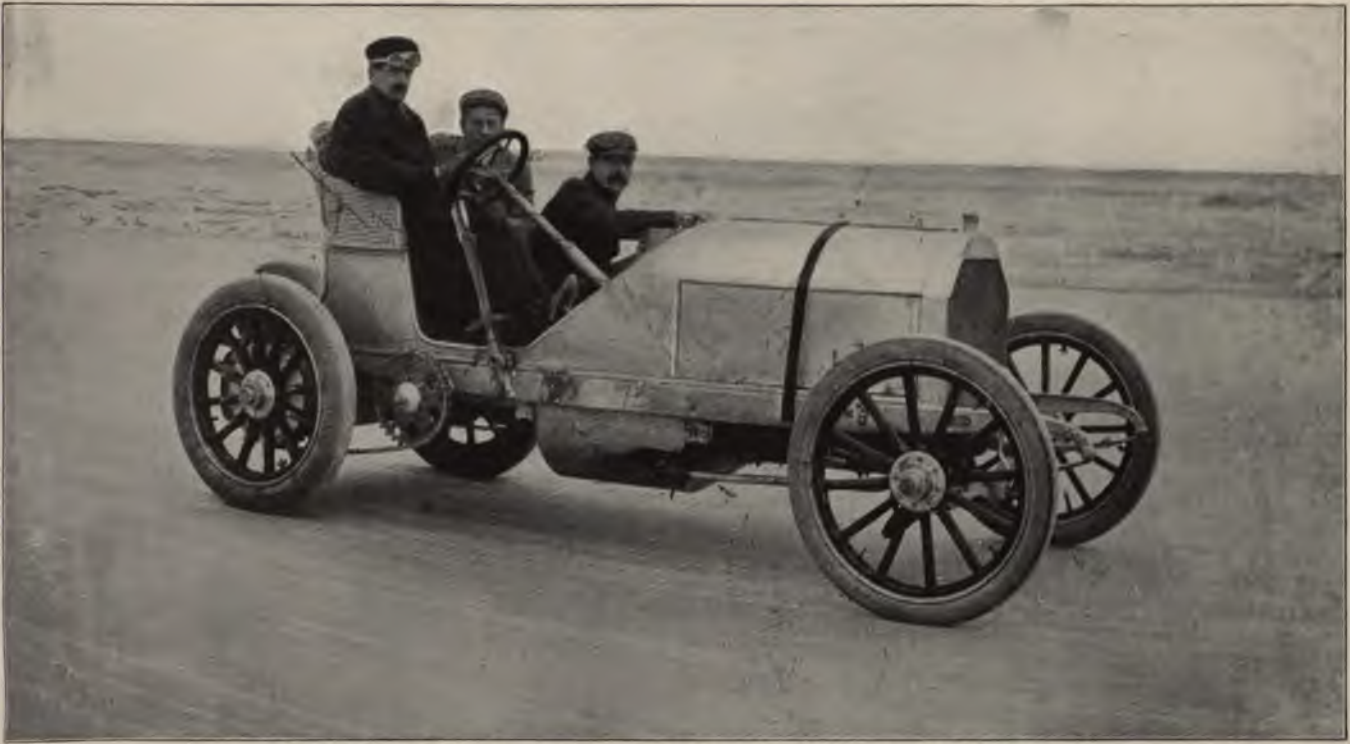
The great difficulty experienced with the pneumatic tire, when applied to motor vehicles, is its tendency to skid or slip sideways on greasy roads. Many devices have been invented and applied to tires to prevent this extremely dangerous tendency. Generally non-skid devices are applied at the wheels, and in most cases form a part of or attachment to the tire itself. They may be roughly divided into three classes: Those which are attached to the wheel, those which are attached to the tire, and those which form part and parcel of the tire itself. The conformation of the tread of the tire itself is often so designed as to form a more or less efficient non-skid device. Thus the rubber tread of the tire may be molded with lateral or circumferential corrugations, as in well known makes of tires; or it may be molded with rubber studs—a satisfactory system which, although perhaps not as effective as metal studs, wears better, does not cause so much damage to the road, and gives a smoother and less positive drive, and consequently does not cause so much strain to the transmission system.

The Kempshall is a British rubber non-skid of unique design. In this tire the tread is flat and has corrugated sides forming high walls, which greatly assist in preventing side-slipping. It has also circular indentations on the tread, these acting as suckers and helping the tire to grip the road. It is claimed that the tire keeps cool by reason of the side corrugations, while the form of tread gives a very heavy rubber surface.

The most common form of non-skid consists of a series of small hardened steel studs with circular or other shaped heads projecting above the surface of the tread of the tire. In order to prevent the studs from pulling out of the tire under the strain of drive and slip, they are in some cases embedded in a non-elastic material, generally chrome-tanned or rawhide leather. In many cases the leather band which carries the studs is permanently attached to the tire by being vulcanized to it in course of manufacture, and not capable of being detached. Such bands are effective against side-slip, while also acting as shields or puncture preventers, but without question they detract from the resiliency of the tire, and thus appreciably slow it. They also increase the difficulty of detaching the tire, and tend to set up undue heat, which may lead to the more speedy disintegration of the tire or the splitting of the casing. With an unprotected tire the rubber affords a sort of cushion which takes up the strain of starting, and so saves both tire and mechanism. When a band is fitted the grip on the road surface is more positive, and consequently unless the clutch is kept in good order and the driver starts very cautiously, considerable strain results. The same applies to the application of the brakes.

In most types of modern studded tires, however, the metal studs are fixed in the rubber tread. This type is the most effective in preventing skidding and side-slipping, but the initial cost is high, and on good roads free from stones it does not wear as well as tire treads which consist of nothing but rubber. On roads which are habitually covered with loose metal, however, the studded tire wears better than unprotected casings.

A type of non-skid which has proved wonderfully efficient



W. K. Vanderbilt, Jr., in his 90-H.P. Mercedes at Tarpon Beach, Texas.

consists of a series of curved chains fastened loosely and diagonally round the wheel tire, the chains being attached at either end to two wire rings lying on each side of the wheel rim. The wheel is thus practically inclosed in a chain cage. The whole contrivance is capable of moving loosely upon the wheel, which prevents the chains chafing or indenting the tire. The chains actually roll on the tire as they come between it and the road surface, but immediately a slip occurs the tendency is to drag the chains sideways, which tendency is resisted by their being anchored to the wire rings.

This non-skid can be attached or detached in a few minutes. It can, therefore, be removed when the road surface is dry and replaced when it is greasy. It does not affect the durability of the tire, nor materially increase the wear of the road surface, and the smoothness of the drive is not affected.

It is important that tires should be fully and equally inflated. The pressures advised by the manufacturers should be adhered to, though if a man is a careful driver and avoids loose stone patches, starts off gradually, does not use his brakes unless necessary, and then not harshly (except in cases of emergency), he may inflate his tires to a lesser pressure with greater comfort and greater economy as regards wear and tear. A pressure gauge, preferably attached to the tire itself, is essential to test the pressure of inflation.

Function of the Tires.

The purpose of a tire is usually to tie together the fellies or felloes of the wheel, as the spelling, properly "tier," shows. This tying duty is now generally performed by the rim, and the so-called tire is relegated to the duty of absorbing vibration. Vibration is not only wearing to the occupants of the car, but to the car itself, and, moreover, it wastes power. True, the car jumps and jerks because of the inequalities of the road surface, but unless the motive power were sufficient to overcome them, these same inequalities would stop the car altogether. The better the tire will swallow the projections and fill up the holes, the less vibration will be felt and the less power wasted. There is a proviso to this, however, in respect to the driving wheel tires. The adaptability of form in the tire must be accompanied by rapidity of restoration, otherwise the tire will drag, and power will be lost in the deformation.

As no tire is perfectly resilient radially, or perfectly rigid tangentially, every driving wheel turns round slightly relatively to the tread, and a lump is formed just in front of the area of contact between the tire and the ground. This lump is constantly being ridden over, and as constantly forming. The part that has just been ridden over resumes its original shape, and so re-expands. In doing this it tends to turn the wheel forward, if it re-form quickly enough. Part of the superiority of the pneumatic tire over the solid rubber tire is doubtless due to the fact that in the former the reformation at the back of the area of contact is practically simultaneous with the deformation at the front of such area, while in the latter the rubber re-forms so slowly that the action occurs too late to be of any assistance. In the pneumatic tire, the elastic medium is operating at all points at the same time—the fluidity and elasticity of the air being practically perfect, and hindered only by the containing envelope. In the rubber tire the movements of one part of the elastic body have little influence on other parts at only a short distance away, the material itself acting as a buffer almost as much as a transmitter.

Solid Tire Considerations.

Solid rubber tires present negative advantages in the way of freedom from punctures (or, rather, their results) and bursts; and if of good quality, size and form, and securely attached, they will run a long time without giving much trouble. They seldom cause stoppages in the course of a run, and where specially flexible springs are fitted to the car, the difference in vibration, as compared with pneumatics, is not so noticeable as might be expected. Steering, however, is vastly better with pneumatics than with solids, probably because the superior elasticity of the former enables them to keep a more continuous contact with the ground than the latter. Pneumatics to the steering wheels and solids to the drivers form a good compromise, in the opinion of many experts, though there is generally more noise than when pneumatics are fitted throughout.

Constituent Parts.

The essential material—compressed air—of a pneumatic tire cannot be much improved upon; but the incidental materials—the rubber and fabric of the casing and air tube—leave a good deal to be desired. The elasticity of the rubber is rather a disadvantage, in that it discounts the action of the air; but the flexibility and the waterproof quality of the rubber are good. Perfect flexibility and perfect inextensibility are what one looks for in a pneumatic tire cover, and though one gets pretty near the latter, the flexibility is sadly lacking. Impermeability is another requisite, and non-liability to burst and slip are still others. Perhaps some day a strong, thin, flexible, non-stretching, puncture-proof and waterproof material may be discovered; till then we must content ourselves with the best substitutes we know of.

The first requisite of the air tube is that it should be nonporous, so that it may fully retain the air. It should be as free as possible from seams and joins, and should fit the cover without either stretching or wrinkling.

The outer cover should be flexible, not only in material, but in design. The sides should therefore be comparatively thin, while the "tread" or running surface may be made thicker to insure durability and resist puncture. The rubber is strengthened by several plies of fabric insertion. Two points are of great value in the design of the fabric. The first is the arrangement of the threads diagonally or obliquely to the length of the casing; this promotes flexibility without incurring either longitudinal drag or transverse instability. The other point is that the threads should not be interwoven; this gives freedom of action to each thread (and hence flexibility), and also prevents the threads chafing each other to their mutual destruction.

Methods of Attachment.

The most usual method of attaching the pneumatic tire to the wheel consists in providing the casing with outwardly-directed edges, and the rim with inwardly-directed edges, so that the edges of the casing hook into the edges of the rim. A modification of this consists in making the rim in two parts, so that one side can be removed at will. This enables the tire to be slid on and off the base of the rim, instead of being forced over the edges. Further, it enables one to see that the air tube does not anywhere protrude between the edges of the casing, before the tire is put in place on the rim and inflated. With the usual single-piece rim, the nipping of the air tube between the edges of the casing is a frequent source of trouble. The means provided for releasing and securing the detachable part of the divided rim are generally rather tedious.

Tire Strains and Sizes.

The friction between the road wheels and the ground tends to cause the tire to "creep" round the wheel. This creeping tendency is naturally more pronounced in the case of the driving wheel tires. To prevent the movement, a number of radial bolts, with specially shaped heads, are passed between the edges of the casing and through the rim and felloes at intervals. By tightening flynuts on the bolts, the edges of the casing are locked firmly in position, and the injurious strain, to which the air valve would otherwise be subjected, is thereby removed.

The most important advice that can be given about tires is to have the very best, and have them of extra size. The different tire makers recommend certain minimum sizes for the carrying of certain weights of car and passenger. The car makers and retailers are too apt to cut down cost in tires, which are always an expensive item. But the purchaser should not be content with these minimum sizes; a few more dollars laid out in "over-tiring" will be very well invested. The larger tires will last far longer, and give greater comfort and less trouble than the smaller ones. A word to the wise is sufficient.

Tire Replacements.

As tire repairing on the road is a thing to be avoided if possible, a complete spare casing and a supply of inner tubes should be carried on the car. This idea can be carried out in several stages of completeness. The rims of the wheels may be made with a detachable flange, so that a damaged tire can be quickly removed and replaced by a good one. Or the rim may be of a duplex nature, so that the spare cover and tube may be carried ready inflated on the outer rim, the whole being interchangeable with similar parts on the wheel and which can be released from the inner part of the rim, which is provided with means for securing the outer parts as required. The provision made for the accommodation of the valve and the locking bolts should be so arranged as not to entail any undue weakening of the wheel itself. The Stepney spare wheel, which is illustrated (see Wheels), goes rather farther than this. Here the ready inflated tire is mounted on a rim which is provided with fittings whereby it may be secured to the wheel. The damaged tire need not even be removed from its place. Or, lastly, one may carry a complete road wheel, particularly where all four wheels are made interchangeable.

HINTS AND TIPS ON TIRES.

How to Take Off a Tire.

When the owner of a car receives the vehicle from the manufacturer, the tires, of course, are in position on the rims. Now, as it may be that some of our readers have just become possessed of their first car, their knowledge of the operation of repairing a puncture is not very definite. Assuming that we have a puncture, the first thing to be done is to remove the outer casing. The first operation is to jack up the wheel from the ground, the jack being placed beneath the shackle of the axle spring, or, in the case of the front wheel, immediately beneath the steering joint of the axle. The wheel should be jacked up until it is a full inch clear from the ground. The next thing is to loosen the wing nuts of the lugs or holding-down bolts, unscrewing them almost to the ends of the bolts.

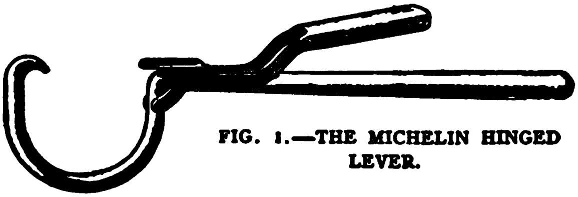


FIG. 1.—THE MICHELIN HINGED LEVER.

For this purpose, at least two tire levers are necessary, and it is always advisable to have double this number, as with a third and fourth lever one can always accomplish the removal with greater ease than with two alone. Starting on one side of the valve, a little distance away, the outer cover should be pressed inward, so as to pull it away from the inturned rim. By means of the wedge end of the tire lever the beaded edge of the tire can be lifted from the rim, and if by any chance it should be stuck tightly it may be released by striking two or three sharp, but not hard, blows upon the bottom of the casing with the shaft of a hammer or other piece of wood. Now having got the edge released from the rim, the thin edge of the tire lever should be inserted between the bead of the casing and the rim of the wheel; the second lever should be placed beside it, and the casing worked out little by little, the first lever preventing the casing from slipping back into its place, while the second

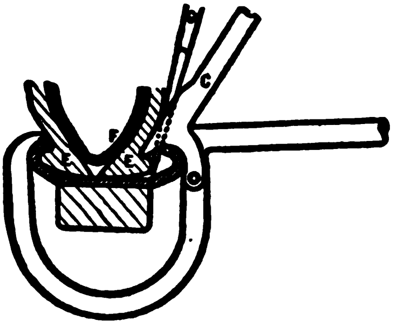


FIG. 2.—HINGED LEVER REMOVING COVER.

The short lever C pushes the bead E from the clinch of the rim, and crutch lever G is then inserted whilst the hinged lever is withdrawn for use farther on.

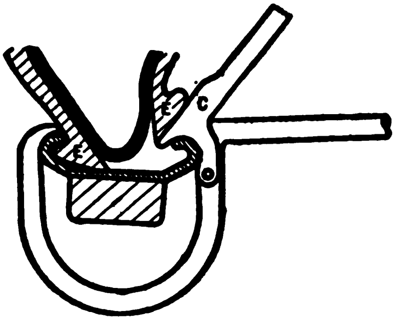


FIG 3.—HINGED LEVER REPLACING COVER.

The short lever C first lifts and then pushes the bead E over the clinch of the rim. The crutch lever is then slipped in with the crook engaging in the clinch of the rim.

releases it for at least eight or ten inches of the circumference of the tire. This being done, the second lever should be placed with its edge beneath the edge of the outer casing, about five inches away, with the handle turned outwards. The first lever should then be held in an upright position, and pressure put upon the second lever, using the rim as a fulcrum. Having got over the first step, the next is to get the first lever beneath the casing and to lift that part of the casing out of the rim also. This being done take away the first lever, still holding the second in the same position. Release the edge of the casing a few inches further, and with the second lever pull over some more of the casing. Remove the lever, and with it repeat the operation until sufficient of the tire has been removed to enable it to be detached entirely by means of the hands alone. Of course, it will be understood that the holding-down bolts will have to be pushed upward while the casing is being removed from that part of the rim which lies opposite to the bolt. The casing having been removed from the one edge of the rim, it will be easy to take out the inner tube for the purpose of repair.

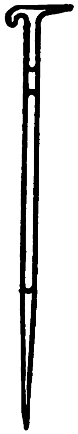
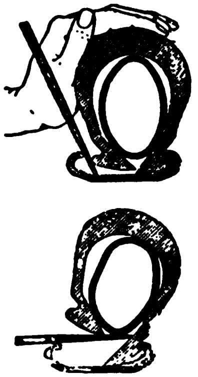


FIG. 4.
CRUTCH LEVER.



FIGS. 5. AND 6.
FLAT END OF CRUTCH LEVER BEING USED TO LIFT BEAD OFF.

Repairing a Puncture.

The repairing of a puncture in a tire is a somewhat difficult and tiresome job, though many of those who have had experience with punctures on an ordinary bicycle tire can hardly believe this, and many proceed to repair a puncture of this type in much the same way as they would do if it had occurred in the tire of a bicycle. Now, supposing that we have a puncture by a small nail. The first thing to do is to extract the nail, marking the place whence it is taken; or, if this cannot be done, only partly remove the nail, allowing it just to hold into the outer casing. When the casing is detached from the rim, if the nail is still in position, it is much easier to locate the position of the puncture than would be the case if the whole of the tire had been removed and the repairer had set out to discover the puncture without any previous guide as to its position. Having discovered the hole in the tube, the next thing to do is to prepare it for the patch, and to do this, first of all rub the surface with sandpaper for, say, about an inch to an inch and a half all round the hole, bringing up the surface quite rough and clean. Then apply solution, spreading it well over the previously roughened surface. Allow this to dry, and in the meantime take a rubber patch, and treat the one side in a similar manner to that already adopted in the case of the inner tube. Apply three layers of solution both to the tube and the patch. While the last application of solution is drying, a piece of thin sheet patching rubber should be cleaned off on both sides and

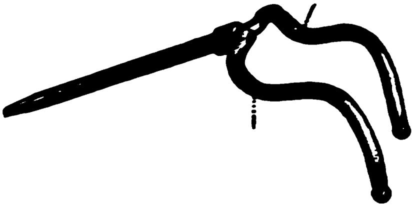


FIG. 7.—FORKED LEVER.

given a coating of solution. When the solution on the patch, inner tube and rubber sheeting is "tacky," that is, not absolutely dry, but sufficiently so to prevent the fingers sticking or the solution lifting, the sheet rubber can be placed over the puncture on the inner tube and the strong rubber patch placed into position over the sheet rubber. The whole should be pressed down lightly together by means of the ball of the thumb or a piece of wood. If the surfaces have been prepared properly and good solution has been used, this repair will occupy about half an hour, exclusive of the time spent in taking off the casing and replacing it. It is always better, however, to carry spare tubes, and when a puncture occurs to take out the tube and to mend it at leisure, giving ample time for the repair to dry completely and thoroughly before it is again put into the tire. It is better not to attempt a

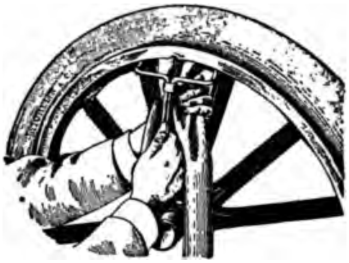


FIG. 8.—FORKED LEVER BEING USED TO REMOVE VALVE.

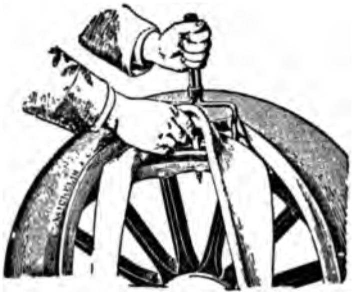
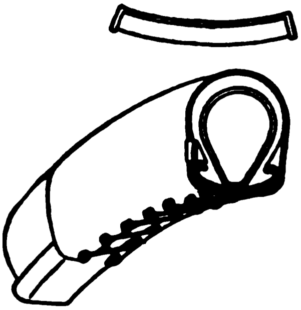


FIG. 9.—FORKED LEVER BEING USED TO REPLACE VALVE.

solution repair at all, but to have a patch vulcanized on to the tube by an expert tire repairer. Most garages nowadays have a proper vulcanizer for effecting such repairs, as solutionized patches are almost certain to give trouble, especially if the weather be warm, and on large or fast cars they are useless. If the hole left in the outer casing by the puncturing object is of any appreciable size, a piece of canvas should be solutioned on the inside of the casing, and the hole in the rubber tread should be filled in with a bit of cotton wool into which solution has been worked.

A Blow-out or Burst in the Casing.

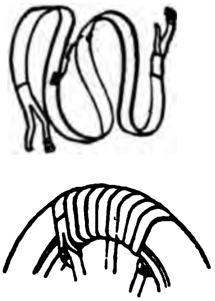
In the event of a burst occurring in the outer cover, it will be necessary to provide some protection for the casing in addition to the ordinary repairs. This is met by using a leather sleeve or gaiter, which is laced over the casing and round the felloe of the wheel. After repairing the inner tube and putting the patch of canvas on to the inside of the casing, the inner tube is blown up to a pressure of about 15 lbs. The sleeve is then put into position, with the packing pieces resting on the edges of the rim of the wheel. The laces are pulled up tightly and secured, and the tire is then blown up to its ordinary pressure. This is but a temporary method of effecting a repair; but it can be safely relied upon for a



A Tire Sleeve Repair.

distance of upwards of two hundred miles. In the case of a very bad rent in the outer cover, it is expedient sometimes to fit such leather sleeves, one being placed inside the casing and the other outside. This is, of course, the extreme method of effecting a repair.

A second method of repairing a burst in the outer cover is by means of a bandage, as illustrated. The one end of the bandage is buckled round one of the spokes behind the burst in the direction in which the wheel revolves. The bandage is then wound around the outer cover and the felloe of the wheel, so that one edge of the bandage is always overlapping the other. The opposite end of the bandage is buckled around another spoke. It is obvious that if the edges of the bandage are presented to the road, they will very quickly wear away, and the repair will not be as effective as when properly executed, its total life being less than half of that when the repair is correctly effected. Tires which have suffered from bursts should always be returned to their makers at the earliest opportunity, so that the cover may be properly repaired and vulcanized. This is absolutely necessary to insure a complete and effective repair.



Tire Repair with Bandage.

To Replace the Tire.

Having effected the necessary repairs to the inner tube, the next point is to replace the tire. If the tire bolts or holding-down bolts have been removed entirely, they should be put back into position, it being first noted that the nicks in the edges of the outer cover which permit of the valve passing through them are opposite to the hole in the rim. The bolts being in position, the valve of the inner tube is also placed in position, and the inner tube itself is then put into the casing, care being taken that it is not twisted. If this should be the case, when the tire is blown up, it will result in another rupture in the tube after a few miles running; in fact, even a few yards may do it. Place a liberal quantity of chalk into the cover, and work it well round the tire. Inflate the tube slightly, only just sufficiently, however, to expand it and prevent it being nipped. Then begin to replace the casing itself. Starting opposite the valve, the valve body should be lifted well up from the bead of the rim, and the edge of the casing placed into position four or five inches on either side of the valve. Pull the valve down as far as possible, but do not strain it. Then with the tire lever work in another four or five inches on either side, lifting up from the bed of the rim the holding-down bolts as they are approached. With these bolts and the valve well up, work as much of the beaded edge of the casing into the edge of the rim as is possible, taking great care that the tube is not nipped between the two edges of the casing. This being done, the rest of the operation is simply a repetition of the former practice—that is, putting in a few inches of the casing, first one side and then the other. The last eight or ten inches are the most difficult of all to get in, and although this is done by means of the lever in the same way as the other portion of the casing, it requires a certain amount of knack, which can only be gained by experience. It also requires a good deal of strength. Supposing the last piece of the casing be in position and the edge engaged with the rim, the tire should be taken in both hands and worked backward and forward two or three times until the circumference of the wheel has been covered. This admits of the air tube settling itself down in position, and if by any chance it has become nipped between the edges of the casing it will give it an opportunity of freeing itself. The tire bolts should be pulled down to the bed of the rim and the nuts screwed on. The tire can now be inflated up to its full pressure, the bolts and the valve nut being tightened up as the internal pressure forces them on to the bed of the rim.

Care of the Tire.

Many tire repairs are occasioned through carelessness, or, in some cases, a want of knowledge on the part of the driver. A fruitful source of chafing on the edge of the tire is the habit of driving close up to a curbstone. Even if a car runs a short distance along the edge of the curb it will chafe the greater part of the diameter of the tire, especially when small wheels are employed. The sides of the tire have the least quantity of material to resist wear, as it is obvious that if these are made very thick they lose a good deal in resiliency. Therefore they are only made sufficiently strong to withstand the pressure to be put upon them. If by accident the sides of the tires become chafed, it is always as well to have the damage repaired by the makers as soon as possible, as this is a comparatively trifling item in the first place, yet if it is left to go and more rubbing takes place, the canvas of the tire will be exposed and subjected to wet, and once the water has thoroughly impregnated the fabric rotting will take place very quickly.

A very fruitful cause of damage is allowing oil to remain upon the tires. Many owners are very careless in this respect. They allow oil to remain upon the floor of the garage, and drive their car in and out, when it regularly picks up grease. This is generally allowed to remain upon the tire, with disastrous results. As all kinds of oils, greases and the majority of acids have a deleterious action upon rubber, whenever any of these come in contact with the tires, they should at once be thoroughly removed. If allowed to remain on the casing, the action of the oil is very slow, but equally sure. It softens the rubber, in the first place, making it into a spongy mass; then, when the air enters through the cracks, it hardens again, and so we get a bad tire, with rubber coming off it in more or less large quantities.

Inner Tube Accidents.

One of the most frequent causes of accidents to an inner tube is by nipping either between the edges of the casing or underneath the lugs. It is imperative, therefore, that these points should be looked to very carefully in replacing the tire. Such accidents are dealt with extensively elsewhere.

The steel rim for the tire is usually screwed into position, the rim being counter-sunk to admit the head of the screw coming down level, or at any rate slightly beneath the level of the bed of the rim. If by any chance one of these screws has not been put down tightly, there is every possibility of its tearing a large hole in the inner tube. It is advisable, therefore, to make certain that every screw is at least level with the edge of the rim, and that no sharp cutting edge is presented either to the edges of the casing or to the tube which the casing generally protects. Unless care is taken in the manipulation of the tire lever, this instrument is also liable to damage the inner tube, and this particularly when lifting the casing into place on the rim. The lever is inserted beneath the edge of the casing and pushed into the rim to obtain a leverage upon it, so as to lift the casing into position. When in this position, unless the inner tube is lifted up so that the end of the lever bears upon the opposite edge of the casing, or upon the bed of the rim, there is every likelihood of its pressing the inner tube on to the base of the rim, so that the whole force of the lift is exerted on to the doubled-up portion of the tube beneath the inner end of the lever and the bed of the rim. When such is the case, it is almost impossible for the tube to escape damage. In order to obviate all possibility of damage by such treatment, instead of inserting the lever to such an extent as to reach the bed of the rim, it is better only to insert it sufficiently to rest just upon the edge of the rim, using that as the fulcrum instead of the base of the rim. With careful handling it will be found that it is just as easy to replace the casing with the lever in this position as in the other.

Cutting at the Edges.

A point at which tires are very liable to suffer, and, unfortunately, very often do suffer, is at the bottom of the outer cover, where it joins on the beaded edge. This is very frequently cut into, and unless great care is taken the tire may burst close to the rim. There are two or three causes which contribute to this cutting and these, by taking a little care, may be obviated to a large extent. Excessive pressure on the tire is one of the chief causes of this trouble. When the tire is only sufficiently strong to carry the weight of the car, it will be understood that a very severe strain is put upon it when it is blown up to withstand the extra weight of the loaded car, and that the lateral strain upon the beaded edges when turning corners must be very great. A slightly heavier tire than is absolutely necessary should always be used. When a tire is blown up very hard, it cannot long stand its own internal pressure and the external pressure placed upon it by the weight of the car; it must give way, therefore, at its weakest point, and this is at the junction of the casing with the beaded edge. On the other hand, if the tire is one or two sizes bigger than absolutely necessary it can be run in a very slightly flattened condition, which will reduce the internal strain very much, and increase comfort.

Rust in the Rim.

A further cause of cutting lies in the rusting of the rims. These should in the first instance be painted, and the tires should not be put into position until the paint has dried thoroughly. In removing the cover from the rim and putting it back again, the paint upon the rim is certain to suffer more or less injury. The places where the paint is removed, both on the inner edge of the rim and on its outer edge, should not be allowed to remain bare for an indefinite period, but as opportunity occurs, should be painted over with some air-drying enamel, having previously been cleaned up with a little worn emery cloth. If the bare places are allowed to remain and the water gets to them in running through the mud, rust sets up and eats its way into the canvas and rapidly rots away the fabric. Driving on slack tires is also responsible for the breaking away of the beaded edge, but most drivers are well aware of the evil effects arising from such treatment, and for their own safety's sake as well as for the sake of the tires take every precaution to keep the tires in a properly inflated condition.

The Preservation of Rubber.

The principal enemies of indiarubber are a strong light and changes of temperature. Strong light is particularly bad for any class of rubber, as its action destroys its elasticity by extracting the sulphur used in vulcanization. This is followed by a hardening of the rubber and the development of small cracks which let in more light, and eventually cause the rubber to peel off the fabric in quite large pieces. As to temperature, this has very much the same effect as strong light, although in not such a high degree. The temperature of a room in which rubber is stored should be about 65° to 75° Fahr. A higher temperature should be avoided; lower ones will not do any harm. It is obvious that one cannot choose the ideal storage for tires which are in position on their wheels, and it is as well to note that the house or garage in which one's car is stored should not be subject to great heat, or that the windows do not admit of rays of strong light being projected on to the tires. Galvanized iron sheds, for instance, attract great heat in the summer time, and are very cold in the winter. They are particularly unsuitable buildings, therefore, in which to store rubber. One peculiarity of the tire is that it is not so liable to decomposition from changes of temperature or the influences of light after it has been used as it is when new. Any spare tires which may be kept should be stored in a room where as even a temperature as possible is maintained, and where they are free from strong lights. A useful tip which is not generally known is that if the tires are washed free from mud or dirt after every run, it will appreciably lengthen their life.

Use the Brakes Carefully.

The cost of the upkeep of tires of many car owners and drivers is no doubt increased by the way in which they apply the brakes, for if a car is proceeding at even a moderate pace, and the driving wheel brakes are applied suddenly, they will entirely lock the wheels, preventing their rotation, or check them to such a degree that there is a dragging action caused by the momentum of the machine drawing the tires over the surface of the road. The result of such treatment is that tires do not last nearly so long as they would do if the brakes were applied gently. There are necessarily times when one has to put down all the brakes as hard as possible to prevent an accident, but such occasional applications are not sufficiently important to be considered in dealing with the upkeep and repair of tires.

Burst Tire Repairs.

When a tire bursts and no new casing sleeve is at hand a sleeve should be applied outside the casing, and it should be fitted slightly out of center with the burst. The object of this is to allow the sleeve to creep into its correct position as soon as the car has run a short distance. It is obvious that, especially if the sleeve is fitted to a driving tire, there will be a tendency for the sleeve to creep a short distance, and for this purpose it should be set in the manner described. The lashing of the sleeve should be turned round the spokes at suitable distances apart, bearing in mind that the sleeve will creep in one direction, and so arranging the lashing to reduce this creeping as far as possible. In addition to a sleeve a similar device can be used inside the casing. Failing either of the above, the tube should be wrapped in canvas at a point coinciding with the burst, and the cover should be replaced, taking care that the canvas fully protects the tube. Before the tube is inflated, the tire can be bound round with rope, so as to cover the burst part and protect the tire at the weakest point, but there should be some air in the tire before the rope is put on, say, 15 to 20 lbs. The rope will not last very many miles, so enough should be secured to enable the lashing to be renewed two or three times. As soon as the binding begins to show signs of failing a stop should be made and a fresh wrapping of rope tightly wound over the nearly worn-out lot. If a third application is needed the second mending should be removed. If it is not there will be so big a lump on the casing that the rope will be worn out almost at once.

Emergency Tire of Rope.

A correspondent describes, in an automobile journal, how, in the event of a hopelessly damaged tire, to get home without damaging the rim. He says: "Having punctured both the inner tube and my spare tube, and being unable, at that time of night (eight o'clock) to effect a repair, I walked to a neighboring farmhouse and bought about 40 feet of one-half-inch rope. After having removed the cover and the tube, I wound this round the rim, parallel with the direction of the car, until the whole rim was filled up and several layers of rope protruded. I need hardly say the rope was put on as tightly as possible. It was then lashed into place by some spare lengths of wire. I then poured some water on the rope, which drew it as tight as possible, and by this means drove to the nearest town (six miles) on the first and second speeds without in any way damaging the metal rim—in fact, the latter never touched the ground."

To Remove Patches from Inner Tubes.

When the tires suffer from punctures, the chief trouble is to get the necessary patch to adhere to the tube, but it is also necessary at times to remove such patches, and if the operation of repairing has been successfully performed the removal is sometimes a matter of difficulty. An expert recommends the use of hot irons for the removal of any patches or bandages on rubber goods which have been stuck down by solution and not by vulcanization. An ordinary domestic flatiron immersed in boiling water for a sufficient time to heat the iron thoroughly is specially mentioned, as by this means the correct heat is obtained, and there is no fear of damaging the principal part. In the event of this method not being available, or a more convenient one being required, take a clean hammer head or other similar piece of metal, and heat this on the cylinder head, or, better still, on the exhaust pipe. To use the heated object, it should be held close up to the patch, or, if the heat is not too great, actually upon it until the whole of the patch and the surface of the main rubber is heated, when the patch or bandage may be easily peeled off without the use of naphtha or other rubber solvent.

Flare Patches.

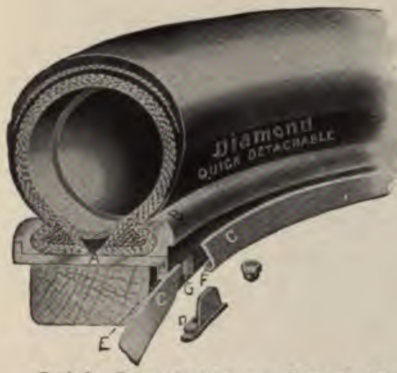
Everyone knows the best way to make good the ravages of a puncture when on the road is to put a spare tube into the casing, but there are times when the spare tube is lacking, and the following has been given as a method of greatly shortening the time of effecting a repair, and, not only so, but it often makes a better repair. The tip is to proceed as usual, so far as cleaning the tube and applying the solution are concerned. At this point, however, instead of a wait of a quarter of an hour or more while the solution is drying, a match is applied to it, and it is allowed to burn for a few seconds, not sufficiently to take hold of the rubber of the air tube, but to burn out the spirit in the solution. The patch is treated in the same way. A second coat of solution is given to each, and here again, in place of another fifteen minutes' wait, a match is applied again and the solution burned. Then without any further wait the patch is put upon the tube. It should be thoroughly pressed home, and, of course, the longer one waits before putting the tube in the better. Two flat pieces of wood, each about seven inches long and four inches wide, may be carried. These can be put one over the patch and the other underneath. Then a hand vise, such as many motorists carry, can be screwed up upon the two pieces of wood, thus bringing a good pressure to bear upon the patch. Some little care must be exercised, as it is possible to give the tube too much pressure.

Permeability of Inner Tubes.

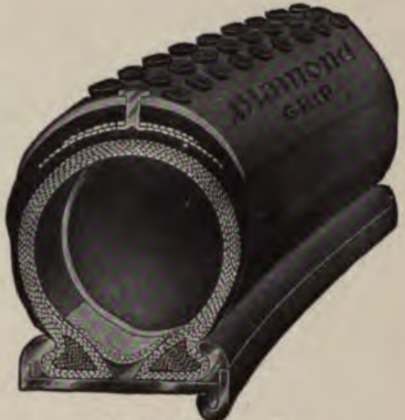
Air contained in inner tubes under pressure diffuses faster through the pores of the rubber when the tubes are heated than when they are cool, and vice versa. Laboratory experiments have shown that, everything else being equal, air diffuses through a rubber membrane at a speed inversely proportional to the thickness of such membrane. That is to say, that it will take three times longer for the air contained in a tube of 3 millimeters in thickness to diffuse than for air contained in a tube of 1 millimeter in thickness. In practice it is found that the original thickness of the untreated rubber sheets of which the tube is formed is considerably reduced by the wrapping with linen bands which is necessary to the process of vulcanization. Again, in practice it is found that the air diffuses from thin tubes with more rapidity in comparison with thick tubes than the laboratory tests have established. Comparing the service of a tube formed of 1 millimeter rubber and one of 3 millimeters, the first, as we have seen, will deflate three times quicker than the second, and will consequently require repumping oftener, while three times more air will have passed through the rubber membrane; and the passage of an oxidizing medium through rubber is by no means harmless. The greater the quantity of air diffused, the more is the rubber oxidized, and so deprived of its elastic qualities, becoming hard, tough and friable. Therefore, for pneumatic tires which support heavy and speedy vehicles, it is advisable, from the economical point of view alone, to have inner tubes of good thickness.

A Good Tire Tip.

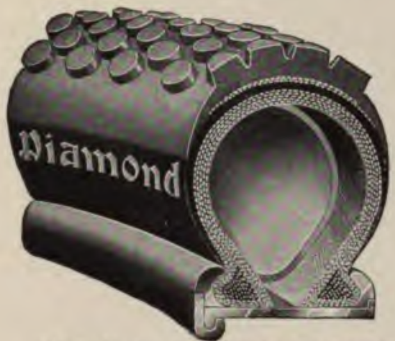
A tire mystery which puzzles a good many people is the peculiar way in which one particular tube on a car will time after time get nipped or burst; sometimes nipping and bursting occur repeatedly with a succession of tubes on one particular wheel, and the suspicion is aroused that the rim of that wheel must be to blame; but tests reveal its accuracy. The following case of the kind was successfully diagnosed and cured: It was the off-side driving wheel tire of the car which the owner described as continually giving trouble, not from genuine punctures, but from nipping and bursting; repeatedly the cover would be found with one of its edges out of the rim, so that the air tube had burst through the orifice between the rim and the tire cover. This had occurred although the cover had been taken off and interchanged with covers from the other wheels; no matter what cover was put on this particular wheel, it never seemed to fit securely. Careful examination showed that the wing nuts on the tire bolts were screwed up quite tightly, but the repairer noticed that one of the bolts seemed to be shorter than the others, and by using a pair of pliers he found that the wing nut on this bolt could be screwed up by the use of some force to the extent of quite three-eighths of an inch more. Here was the explanation. The thread of that particular bolt was too tight a fit for the wing nut, so that, although the latter appeared to be screwed up as far as it would go, it was merely screwed up to the tight part of the thread, but the head of the bolt inside the tire was not drawn down into close contact with the edges of the casing. Consequently, this bolt had been



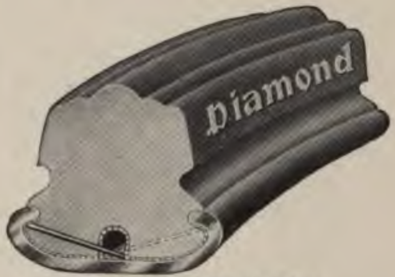
Quick Detachable on Marsh Rim.



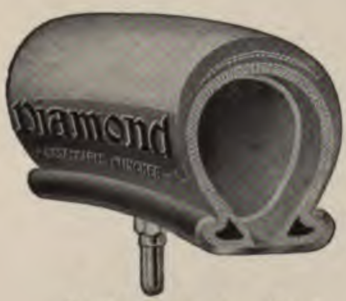
Anti-Skidding Type.



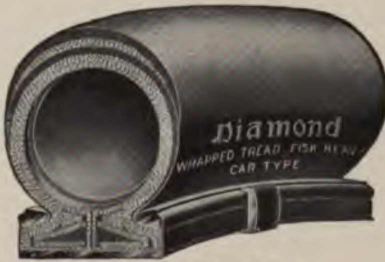
The Bailey "Won't Slip" Tread.



Diamond Solid Tire.



Regular Clincher Type.



Heavy Car Type.

Diamond Wrapped Tread Tires—The Diamond Rubber Company, Akron, Ohio.

the cause of repeated failures, the edges of the cover slipping out from between the rim and the bolt, and sometimes nipping, and at other times bursting the air tube. It follows that every tire bolt should be suspected of similar imperfection, and the manipulator should not be content to screw up the wing nut as far as the fingers can turn it; but if the length of the bolt projecting beyond the wing nut is not what it should be, pincers or a spanner should be used to force the nut to draw the bolt down further.

Burst Casings.

If the burst is on the tread, remove the entire casing, wash out that part adjacent to the burst with some gasolene on a rag, and remove all traces of French chalk. A thick coat of solution is now applied right across the inside of the cover, say three inches each side of the burst; solution a piece of rubber or a tire patch of suitable size, and when ready apply just over the burst. This will keep wet out. Next cut three or four pieces of solutioned canvas in progressive sizes, and solution both sides. The first piece will be somewhat larger than the rubber patch, the next larger still, the third large enough to cover all the others, and extend from edge to edge. Now cut a piece of canvas a little thinner in texture, solutioned on one side only, wide enough to cover the previous pieces and long enough to come over the beaded edge at each side. It will be a messy job sticking them in, and perhaps you had better solution as you go on; but if you are in a hurry you can do as above, and stand the doubly-solutioned pieces on edge to dry (they will naturally curl, and stand like a roll of linoleum). Of course, if you can spare the time, or are doing the work at home, the vulcanizing fluid will make a much sounder job.

For side bursts and torn-away beads there is nothing but the gaiter or sleeve, and the application of this is well understood.

Tire Brushes.

When one has to change an air tube by the roadside, it is often very difficult if the weather is at all wet to avoid getting mud and grit into the tire. Even in dry weather there is some difficulty this way, but it is easily overcome by the simple expedient of carrying a strong hard brush. In fact, a domestic scrubbing brush is as good as anything, although there is another kind, with very stiff bristles and a handle a foot or so long, which is handier still. When the wheel is jacked up, it can be turned round, and all the dust or mud brushed off the cover and off the rim, so that when the tire is opened, if the most ordinary care is taken, no grit or dust gets into it. There are a good many so-called porous air tubes, which have really become porous through the quantity of sharp grit which has been allowed to get into the tire when roadside repairs have been carried out. The same brush is often useful, too, when a preliminary cleaning is desired on any part which is not easily scratched.

Mysterious Tire Leakages.

Whenever it is necessary to replace a burst or punctured air tube on the road, it is advisable before putting in the new tube to examine the nut which holds the valve to the air tube. Very often this nut shakes loose through continual vibration of the car, and also there is likely to be a slight contraction of the rubber between the nut and the valve seat, so that when it is required for use there is a mysterious leakage which cannot be traced to a puncture. Before putting the tube in it is advisable to try this nut with a spanner, and screw it down as tight as possible. A thin bicycle spanner will be found most suitable for the purpose, and it should be, if possible, one of the hexagon hole variety, and not a jaw spanner. The turned-up edges of the valve plate necessitate the use of a spanner with very thin sides. The best form of spanner is one made out of a piece of steel bicycle tubing.

Leaky Tire Valves.

Having a leaky tire valve, which on examination showed no defect either in the rubber with which the joint is made or with the metallic seatings, numerous attempts by the owner at tight screwing-up and the application of soft-soap failed to effect a remedy, but when a little ordinary sugar dissolved in water was rubbed into the valve rubber, the trouble immediately disappeared, and the stoppage of the leak was permanently effected. This is useful to know, as apparently the rubber is not caused to stick in any way, nor is any injury done to it.

Makeshift Valve Cap.

If the valve cap of a tire is lost at any time, a piece of rubber, leather or rag should be put over the orifice and secured with a rubber band or piece of string round the stem, as if any dust gets into the valve, it is almost certain to leak. It is always a good plan to make one or two strokes of the pump before screwing it to the valve, so that any dust or dirt which has lodged in the tube or nozzle is blown out and not forced into the valve.

False Alarm of Puncture.

It very often happens that a false alarm of puncture is raised through a tire suddenly going down. It is well, therefore, always to make sure that it is a puncture before commencing to detach the casing; very frequently it will be only the valve at fault. This is particularly the case when a tire has gone down gradually, and not with the sudden hiss that betokens the incursion of some intruding obstacle. It is decidedly aggravating, after you have taken the trouble to open a tire in search for a supposed puncture, to find that both casing and tube are sound, and that the deflation was caused solely by valve failure.

Care of Tires in Winter.

When the wintry weather approaches, advice as to the care of tires on vehicles left stabled or garaged for considerable periods of time will be of use:

(1) When the car is run occasionally, jack up the carriage so that the wheels do not support its weight, and the fabric liners are not continuously under stress. Four wooden tripods, shaped at their apexes to take the front and rear axles at points close up to the wheels, are the simplest and least expensive means of doing this. It is not necessary to deflate the tires.

(2) When the car is out of use for several months. Before storing the car, it is advisable to take down the tires and make a careful examination of the casings, inner tubes and rims. If the first-named require repair of any description, this opportunity should be seized for having the work properly done. The covers should be scrubbed thoroughly free of all dirt, and after being dried should be examined for traces of wear or cutting. If the repairs necessary are beyond the skill of the amateur repairer, it is a good plan to send the tires to their makers with an intimation that they are not required back in a hurry; the makers will then give more deliberate attention and more careful treatment to the requisite repairs. Tires that are not in need of any repair should be scrubbed thoroughly with water, and after being dried inside and out, the covers should be coated inside with graphite or chalk and hung up in a dark, cool place. Air tubes having been examined for possible flaws, and, if necessary, repaired, are best preserved by being inflated just sufficiently to make them assume perfect rotundity; they should then be hung up in that inflated condition. Spare tubes should be unpacked and similarly treated.

The Care of Rims.

Automobilists are sometimes inclined to be somewhat careless in many respects with regard to the rims to which the tires are attached. Now it often happens that after running on a deflated casing, or as the result of any slight accident, the rim gets knocked slightly out of shape, causing the edge of the rim to have a certain cutting action on the beaded edge of the tire. The rims therefore should be examined from time to time by jacking up the car and turning the wheel round, making a close examination of the edge of the rim in which the cover fits. By this means the slightest dent or malformation of the rim is detected immediately; and once discovered it can be remedied in the following manner: If the edge has been knocked down or flattened, it is rather difficult for an amateur to conveniently repair it himself, but generally a competent blacksmith can put it right, with the aid of a pair of tongs. On the contrary, if the damage arises from slight bulges, they can be removed by means of a small hammer carefully used in order to prevent denting in the rim. It must not be overlooked that these little attentions remove the paint from the rim, and it is therefore necessary afterwards to give the parts operated upon two or three coats of paint and varnish, as an unpainted or badly painted rim will soon rust, and a rusty rim will spoil more tires than anything else. Frequent examination of the state of the edge of the rims is almost a necessity, if the automobilist wishes to keep his tires in good condition, and secure long life and durability of the casings.

Examination of Tires.

At the time of the year when one may reasonably look forward to the coming of spring, it is a commendable practice to remove the tires from wheels and to subject them to a thorough examination. Any cuts which may be found should be cleaned out with naphtha, and filled in with rubber solution, which should be allowed plenty of time to set before the edges of the cut are closed together. Special attention should be given to the fabric. If any dark patches are to be seen, they indicate that damp has penetrated through some cut in the rubber casing, not necessarily opposite the mark on the fabric, but probably very near to it. This puncture should be sought for very carefully, for it may be only a small one, and it should be closed up, while the damp should be extracted from the fabric by placing it in a moderately warm atmosphere and allowing it to remain there for some time. If the tire is in such a condition, either as to its fabric or its rubber casing, that to attempt a home repair would be out of the question, the opportunity would be a favorable one for sending it to the factory for necessary repairs. When replacing the tire, French chalk should be used liberally, though care should be taken not to be too lavish in this direction, for this reason—that if too much is used, the chalk has a habit of forming itself into hard lumps, which adhere to the fabric, and the friction of the inner tube upon these lumps, smooth though they will be, will eventually thin down the walls of the tube to such an extent as to make its bursting a very probable event.

Clearing Away Chalk.

The chalk within a tire casing should never be washed out, although some professional drivers are very fond of so doing, because it is a quick and easy method of getting rid of it. But, like most proceedings that avoid trouble, it is a very undesirable thing to do, for the reason that it is seldom that sufficient time can be allowed to permit of thorough drying, and if there be any weak places in the fabric the moisture which penetrates them only serves to weaken them the more. The proper way to get rid of the spent chalk from the interior of a casing is to brush it thoroughly with a stiff brush, and then rub the inner surface well with a clean cloth dipped in methylated spirit.

Preserving Rubber Tires.

Frequently information is desired as to how to preserve rubber tires and inner tubes from the effects of the atmosphere or light when it is required to store them for any considerable time. The following is said to be an excellent preservative for rubber under all conditions: An ordinary box is required which is capable of taking the outer cover without distorting it; to this a light-tight lid or cover should be fitted, or it can be covered over with a cover of green baize. When the tire is in position, a saucer or beaker containing turpentine should be put in the center of the box, it being claimed that this will certainly prevent any deterioration of the tire, however long it is stored. The fumes of the turpentine are of somewhat the same nature as the rubber emanations, and probably also the principal reason for the preserving properties is that the fumes of the turpentine keep out the air, and so prevent oxidation of the rubber, while the covering shuts out the light.

Destructive Effect of Grease.

Beware above all things of allowing oil or grease to get and to remain upon the tires. All fatty substances are detrimental, as they act as a solvent upon the rubber. This can be proved easily by rubbing vaseline upon a piece of an old tire. The vaseline will cause the rubber to become spongy, and when dry it will crumble, and can be rubbed into powder by the friction of the hand. It is most important, therefore, that the rubber of pneumatic tires should at all costs be protected against grease. Tire manufacturers state that they have had tires returned to them in which the stiffened edge had been rotted off completely by a neglected lubricator allowing oil to trickle down on to the tire. Lubricators which are in positions likely to admit of this should, therefore, be frequently scrutinized. Also care should be taken that no part of the moving mechanism of the car throws oil on to the tires. For the above reason, spare tubes should always be placed in rubbered cases whenever they are likely to come in contact with oil cans, oily cloths or tools.

Testing Rubber.

It is not difficult to test the quality of indiarubber, inasmuch as if it does not contain adulteration it will float on water. To effect proper vulcanization, only about three per cent of sulphur is necessary. Tubes which are made of red rubber, while stronger, are not so elastic as those made of gray rubber. The red color is given to rubber by the use of metallic oxids, chiefly antimony. When so treated, the elongation is about five times its length when not more than fifty per cent of oxids are used. Gray rubber, which is free from adulteration, except the necessary sulphur, should stretch to seven times its own length.

Wear on Front Tires.

Abnormal wear on the front tires of a car is not always due to any defects in the tires themselves, or to extra weight which may be placed thereon by bringing the engine too far forward over the front axle. The most probable cause is that the front wheels are not in alignment with the rear wheels; that is to say, they are bent either inward or outward, so that were the wheels to run on their true plane they would either converge towards one another or take the opposite course, according to the way in which they had been set. This is not the only cause, however, for while the front wheels may be in perfect alignment with the rear wheels, they may yet, through some defect in the design of the steering, or through some bend or backlash in the steering gear, not fall to the proper angle to which they should fall when turning a corner. If one suspects his front wheels of being out of truth, a good test is to deflate the tires of those wheels sufficiently to let the weight of the car spread the tires without actually pinching them between the road and the rim. Before deflating the tires, the wheels should be set straight and when the tires are sufficiently deflated the car should be pushed along and a curve described to the right. If there is any error in the steering, the soft tires will be found to roll in one direction on the one wheel and in the opposite direction on the other. It is well to straighten the car and repeat the experiment in the opposite direction for verification of the cause of the trouble. If any defect in the steering is found, the best course is to return the car to the makers or to put it into the hands of a good repairer, who, for safety's sake, should be asked to make a careful examination and to point out to the owner exactly where the steering is at fault.

Wear is sometimes caused on the front tires owing to a narrow steering-lock, so that they rub against the frame, springs or mudguard brackets when put hard over. Small hard wooden rollers mounted on the frame will take the rub and prevent damage.

Rubbing Tires.

It is a very good plan to jack up the front wheels and then to put the steering wheel hard over, so as to give them full lock first in one direction and then in the other. When the road wheels are at the extreme lock, that is to say, turned as far to the right or left as possible, they should be revolved to see whether the tires touch the frame, the springs or the brackets which hold the mudguards. If the tires rub on these or anything else, it means that they will be damaged whenever the helm is put hard over. In many cases it will be found that by having the mudguard brackets taken off and reset to a slightly different shape by a blacksmith, proper clearance can be given; or, if this cannot be done, small hard-wood rollers may be mounted on the frame to take the rub of the tire, and keep it from actually touching anything but the road. It is also well to examine the back guards carefully for the same defect. The trouble here is, of course, quite different from that at the front. What generally happens is that the mudguards are placed rather too close to the wheels, and consequently when the car is fully loaded and running on an uneven road, the wheels, or rather the tires, bump against the guard or its supporting bracket. It is generally the bracket which does the harm, especially if there is a projecting nut or nuts. These projecting nuts occasionally do very serious damage indeed to casings, as they cut large pieces out of them, and in extreme cases gashes a foot or more long are caused in this way. The remedy is to get a blacksmith to set the wing brackets higher.

Guide to Correct Inflation.

A very good guide to tire inflation when there is reason to doubt the accuracy of the pressure gauge on the pump, or when the driver does not know what pressure is suitable for a particular car, is to take two of the spokes, one in each hand, and stoutly shake the car, noticing whether the wheel moves to and from the operator while the part of the tire on the ground remains stationary. If any of this side roll is apparent, the tire is not sufficiently inflated.

Non-skidding tires should be inflated very hard—70 lbs. pressure per square inch at least, and from 95 to 120 lbs. per square inch when fitted to heavy cars. It is almost, if not quite, impossible to burst a tire by inflation alone, provided the fabric is perfectly sound. The temperature of the atmosphere in summer must be taken into consideration with respect to the inflation of tires. A tire can only burst when the strands of which the fabric is composed break one after the other. The continual rubbing of these strands will cause the fabric to come to grief very quickly when the tires are not properly inflated. With the use of compound pumps, or those which are worked from the engine, the required pressure which is absolutely indispensable can be obtained without the excessive labor necessary with ordinary hand pumps.

Repairing Studded Tires.

Studded tires are so much used nowadays that it is pretty generally known their life depends to a very large extent upon the studs. That is to say, pulling out of the studs through violent braking or fierce clutching results in their premature decay, because the hole left by the stud which is pulled out lets in wet and dirt, so that the foundation of the tire is rotted and cut away, and it succumbs prematurely, merely because of two or three leaks which have been caused by the pulling out of the studs. Holes left by missing studs should therefore be filled up just the same as a bad cut is filled up. It is a question whether it could be done satisfactorily with the ordinary tire stopping such as one uses for cuts, but there is no reason why the holes should not be filled up and vulcanized just the same as a good vulcanized repair to the casing is made.

Carrying Spare Tubes.

In carrying spare tubes in a waterproof bag, see that the large thimble cap to the valve is not screwed on so that the pin in the dust cap projects beyond it, otherwise it will perforate the tube sooner or later.

Prolonging the Life of a Solid Tire.

The following is a plan adopted to prolong the life of solid tires of the two internal wire pattern, which, although not worn down, were cut through parallel with the wires in the channel, sometimes for several inches, causing the rubber to bulge up. After using sundry solutions unsuccessfully the motorist would try clipping the rubber down as follows: Taking the ordinary cotter pin, about three-sixteenth inch diameter and 2 inches long, he flattened the head in a vise and filed the points as in the illustration, Fig. 1. He then punched holes through the rubber with a nail of about the same diameter, and drove the cotters into the holes, first opening the

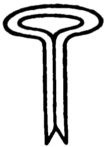


Fig. 1.

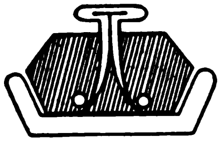


Fig 2.

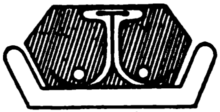


Fig 3.

ends of these slightly, so that they had to be nipped together when driving in. This allowed them to open to the right and left, when the points touch the channel as in Figs. 2 and 3. The cotters should be held with pliers when being driven in to keep the head in the right direction and to prevent buckling, and the pins must be hit squarely, otherwise the cotters are sure to buckle when they first touch the channel. Care must be taken not to crack the head of the cotters when they are flattened in the vise, but only just close the eye. One of the tires experimented on was cut through, and the rubber hanging down for 16 inches, the cotters in about 3 inches apart, and after driving the car over one hundred miles not one of the pins broke or shifted its position.

Expansion of Solid Tires.

Users of solid-tired vehicles should note that a gap of about an eighth of an inch between the ends of the tire will always prevent trouble caused by the tire coming out of the rim. The small gap allows the tire to expand under the strain of traction without butting against its opposite end with sufficient force to dislodge the tire. When the tire has permanently expanded to such an extent that the ends are normally in contact, one end should be lifted from the rim and a slice cut off it to maintain the gap.

Spare Tires.

Most automobilists when starting on a long tour or drive, especially when the tires on the wheels show signs of wear, provide themselves with a spare outer casing and an air tube or tubes. The chief trouble in connection with the spare casings is that there is no suitable place provided for carrying them on many of the older cars. Some owners, for want of a better place, fasten them on the back of the car, and in many cases carry a spare air tube inside the casing, partially inflated, thinking they could not have a better place in which to carry it until it is required for the purpose of repair or replacement. In reality, no place could be worse for carrying an air tube than inside a casing, where it is, especially when fastened at the rear of the car, subject to all the dust and dirt thrown up by the hind wheels. This dust, with its small particles of grit, is carried inside the casing and settles at the bottom between the air tube and the casing, acting like a rough file on the surface of the air tube, the vibration of the car rubbing the surfaces of the air tube and cover together, with the dust acting like emery paper between. Air tubes should not be carried in this way. They should be folded up, and the valve wrapped up in rag and placed in a special bag well dusted out with chalk. Where the type of body permits, a drawer or false floor should be provided beneath the rear floor boards, in which a spare tire may be carried in safety. Modern cars are fitted with irons on the body and footboard for carrying spare casings.

Tires, Approximate Measurement in Metric Units—See Metric System.

Tires, Care of—See under Care and Maintenance.

Tires, Choice of—See Choice of Tires.

Tires, Examination of—See Overhauling.

Tires, Expansion of Solid—See under Tires.

Tire Shoe—The outer casing of a pneumatic tire.

Tire Sleeve—A sleeve or gaiter for covering an injured portion of a tire.

Tires, Soft—See under Loss of Power.

Tires, Solid—See Tires, above.

Tires, Solid vs. Pneumatic—See articles under Solid and under Pneumatic.

Tires, Spare—See under Tires, above.

Tire Tank—A receptacle for compressed air, carried on the car for the inflation of tires. See Air Bottle.

Tires: Their Care and Repair—Leaving out of consideration absolute punctures, nine-tenths of the tire troubles of motorists come from lack of inflation. The use of a gauge to determine the pressure will show that not one tire in a hundred is sufficiently inflated. Insufficient inflation permits the rubber and fabric to chafe and separate; it causes the tire to flatten and become rim cut; it permits the rubber to creep away from the fabric by being rolled; it generates friction and disintegrates the rubber. The average car owner fears to inflate his tires, believing he is courting explosions. As a matter of fact he is absolutely on the wrong track. Guesswork will not do in the matter of inflation; a gauge should be used, so the motorist will know what he is doing. Under no circumstances should the air pressure fall below that given in the following table for various sizes of tires:

Size—Inches	Front—Pounds	Rear—Pounds
3	50	60
3½	50	60
4	70	80
4½	80	90
5	90	100
5½	110	110
6	120	120

If there is any flatness on the tread of the tires after they have been inflated as above, it is safe to presume the car is overloaded. There is a limit as to what a tire will stand in the matter of loading. The following table gives a safe limit and this should not be exceeded. The weight given is the weight of the load on each wheel without passengers; that is, a car having tires 34 by 4 inches will stand a load of 700 pounds per wheel, or 2800 pounds for the weight of the car:

Size of Tires—Inches	Pounds per Wheel	Size of Tires—Inches	Pounds per Wheel
2½	225	4 x36	750
3	350	4½x32	700
3½x28	400	4½x34	900
3½x30	450	4½x36	1000
3½x32	550	5 x34	1100
3½x34	600	5 x36	1200
3½x36	650	4 x40	1200
4 x30	550	5 x40	1300
4 x32	650	6 x40	1400
4 x34	700		

Prevention of Sand Blisters and Mud Boils.

The tires should be examined at frequent intervals for cuts. These cuts should be cleaned from any sand and dirt which may have entered them, the gash washed out with gasolene, and rubber cement put in the gash. The gash should then be wound with tire tape until the car is again taken out. If the gash is a severe one, the cut should be vulcanized at the earliest possible moment. Neglected cuts of this kind with ordinary tires are the forerunners of sand blisters and mud boils.

Methods of Storage.

Tires should not be stored or left off any length of time unused in the direct rays of the sun or kept in dry, warm quarters. Under such conditions the rubber quickly loses its elasticity, becomes hard and soon develops innumerable fine cracks. A continued exposure as above will render the best tire practically valueless in a few months. When buying a new casing or inner tube, it will be wise to see that the dealer has not had it displayed in his windows.

If gas is used for illuminating purposes it also is detrimental to have the tires stored in such a room for long periods if the ventilation of this room is not perfect.

To secure the longest life and the greatest amount of service from a tire, it should be stored in cool, dark quarters.

Oil Softens Rubber.

Never allow a tire to stand in oil at the garage or elsewhere, and be particular to wipe off any oil which may drop on the tires at any time. Lubricating oil greatly softens the rubber, makes it pasty and glue-like in consistency and takes all the resistance and elasticity out of it. This oil may be cleaned from the tires if necessary with gasolene, as gasolene evaporates quickly and does not result in injury.

Support the Car When Idle.

If the car is jacked up and supported on horses—which can be made very cheaply—it will add greatly to the life of the tires, as they are then bearing only the pressure of the air with which they are inflated; whereas, when supporting the weight of the car this weight, often several thousand pounds, is exerting a continual and unnecessary strain on the casing walls. By adopting this course it is estimated that the life of the tires will be increased by at least half the time the car stands idle.

Worn-Down Treads.

As soon as the tread wears down until the fabric is exposed, the tire should be immediately removed and sent to the factory for re-treading, otherwise the fabric will soon be destroyed and the tire permanently injured in consequence.

Fabric of Tires.

When embedded in rubber and not subjected to strains or weakened by bending as above, the fabric used to reinforce the tire will retain its strength indefinitely. As soon, however, as the rubber is removed and moisture from the road is permitted to penetrate, the fabric begins to disintegrate and in an incredibly short time its strength and resistance are gone forever. If water is permitted to reach the rim and the rim is not protected from rust, the water and rust will soon destroy the fabric and cause a blow-out. Do not let a tire stand in water if it can be avoided.

"Don'ts" for Tire Owners.

Do not stint yourself on the use of free air.

Do not permit wheels out of true to remain so; they will soon wear out the tires. Wheels should track; axles should be straight.

Do not permit grease or oil to remain on tires; clean with gasolene and dry immediately.

Do not permit rims to become rusty; cover with enamel, paint or shellac. Before applying tires, coat the rim with graphite and the tire will be easy to remove.

Do not let dents and sharp edges remain in the rims; these will cut the edges of the tires.

Do not apply brakes so hard as to skid the wheels; this is what tears tires to pieces.

Do not round corners at top speed; remember that in turning corners, particularly when a car is loaded, there is great strain on the tires. Figure this out.

Do not let the tires rub the curb; the steering knuckle may become bent and the tires badly worn on one side.

Do not let in the clutch so that the car starts with a jerk; this tears the tread of the tires and is apt to part the rubber from the fabric.

Do not permit water to creep between the tires and the rims; the fabric will be rotted from the water and from the rust that will form on the rims.

Do not run at speed over roads that have rocks or crushed stone on the surface; give the tires a chance to respond to the inequalities of the road.

Do not drive in street car tracks; they will cut the tires on the outside edge in a short time.

Do not take railroad tracks, bridges, crosswalks, etc., head on and at speed; take them at an angle and slow down, so as to avoid pinching the inner tube.

Do not guess the tires have enough air; put on a gauge and know it.

Do not go out without an extra casing, two extra tubes, a repair kit, a pump and an air bottle. The last-named is one of the blessings of motoring; it has taken away half the troubles.

Do not become hasty or excited in making a tire repair; time will always be saved by taking things as they come and making the best of them.

Do not permit a car to rest on a deflated tire; it will soon cut the casing and pinch the tube.

Do not fail to use talcum or soapstone in the casing when making a change or when putting in a new tube; it prevents friction and adhesion

Do not let lug nuts, valve nuts, valve caps, rim nuts, or any other part become loose.

Do not let the valve stem be exposed to mud and dirt; secure a cap for it and always use it.

Do not run a tire flat; if necessary, because of the absence of another casing or repair kit, remove the casing and destroy the rim rather than the casing—it will be cheaper. Better still, procure some rope and make a temporary tire, first removing the casing.

Do not permit small holes or cuts to go unvulcanized; a stitch in time is a certainty in this case.

Do not throw the extra inner tube under the seat and amid all the other stuff carried; deflate it, wrap it in a water-proof bag and pack it away carefully.

Do not forget a few extra valves to be carried in the repair kit.

Do not use tire chains more than is absolutely necessary; they can do the tires no good.

Do not drive on the side of the road when it can be avoided; this puts a terrific strain on the tires.

Tire Tool—An instrument to assist in removing a tire-shoe from the rim.

Tire Valve—A valve inserted through the rim of a wheel, by which a tire may be inflated. It prevents the return of the air pumped into the tire.

Tire Valve and Bolt Nuts, Attention to—See under Driving.

T-iron—A rolled wrought-iron bar whose section is like a letter T, or any T-shaped iron piece.

Titanic Iron Ore—A mineral oxid of iron and titanium. Used in making special steels.

Titanium—One of the metals of the tin group, found in the metal rutile and various other titanic ores.

T-joint—A welded joint for uniting pieces of bar-iron at right angles with each other.

Toe—In machinery, (a) the lower end of a vertical shaft resting in a step; (b) an arm on the valve-lifting rod of a steam engine.

Toggle Joint—A joint between two parts which have to be moved away from, or drawn to, each other. See Joints.

Toll-bridge—A bridge where toll is required to be paid by passengers or vehicles passing over it.

Toluene—The hydrocarbon, $C_7 H_8$, a colorless liquid obtained from tolu and other resins; methyl benzene. Used in the manufacture of rubber goods.

Ton—The short ton is a weight of 2,000 pounds, the long ton 2,240 pounds avoirdupois.

Tongue—A projection or ridge on the edge of a plate or board, adapted to fit into a groove of an adjacent piece; also used in sliding parts of machinery.

Tongue Joint—A split joint made by inserting a wedge-shaped piece into a corresponding split piece.

Tonneau—The rear seat section of an open automobile, originally entered from the rear (an obsolete style), but now from the side, containing a seat or seats for from two to five passengers. The term tonneau was originally applied to a car containing such a rear section, entered from the back, but is now generally used only of the rear seat portion of the body. Pronounced "ton-no." The word is the French term for "tub" and came into motor-car use from the shape of the tonneaus originally fitted.

Tonneau Floor, Drain-holes in—See under Carriage Work.

Tonneauette—A small rear seat section of an automobile body; also called a "baby tonneau."

Tooling—A term used to denote machine processes in general. Any operation carried out by mechanical tools—a lathe or any shaping, grinding, planing, or milling machine—may be termed "tooling" as distinct from fitting, erecting or assembling, all of which involve hand labor as distinguished from any machine process.

Tools for Touring—See Touring Outfits.

Tools, Spare Parts and Accessories—There are many useful articles which it is desirable to carry on a motor car or to keep in the private garage, and it is easy to spend quite a lot of money for articles coming under this head. The automobilist should therefore exercise judgment as to what is or is not worth his while to purchase. Some articles may pay for themselves in one way or another in a very short time; others will be more trouble to carry than they are worth.

One soon discovers that very different prices are asked for the same things by different houses. Very naturally, car manufacturers almost invariably charge more for accessories than firms whose principal business consists in dealing in such articles. Get the catalogues of a few such firms, and having decided which you like best, deal as far as possible with that one. Regular customers usually receive better attention than casuals. Before starting on a tour of any great length arrange with the chosen firm and the makers of your car as to the forwarding of anything you may require while away. If necessary, open a deposit account. Of course, a good many things one can buy satisfactorily at local supply houses, but it is a great convenience sometimes to be able to wire for any special articles and receive them by express without delay. Where no arrangement has been made, it is best to wire the money with the order, and thus avoid any reason for delay. Take a catalogue with you so that you may know just how much to remit, including expressage if necessary.

Some things—spark plugs, for example—can be bought at all sorts of prices. While the best is the cheapest, the highest priced are not always the best, though the lowest priced are seldom satisfactory. A fair price and a good name may be relied on as guarantees, in the ordinary way. Never buy imitation things which look as good as the originals but which cost less. Remember that business is not philanthropy.

No car can be considered ready for the road unless a very complete range of tools and spares is carried. The average automobilist, when purchasing a car, pays a certain amount of attention to the outfit in this direction, but when it comes to stowing away the various necessaries he frequently displays an appalling want of method and tidiness. So long as everything which he considers necessary is secreted somewhere in the car, he is satisfied. It is only when the roadside stop occurs and he wants a particular tool, that he regrets his lack of system. We have all seen a car owner peer into every corner and crevice in a car in search of some trivial object which he should be able to place his hand on without a moment's hesitation. Even if he does know where the things are placed, they are frequently not in a fit state to be handled.

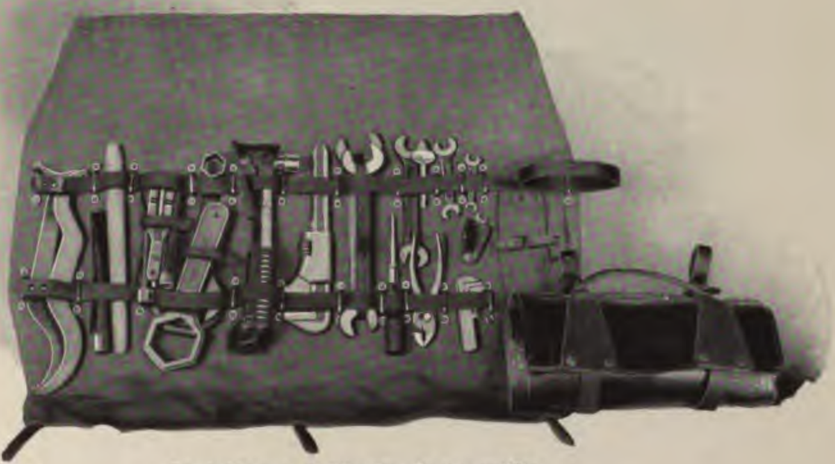
The comfort of having everything in its own special place, ready for immediate use, and in a state of cleanliness, will well repay the automobilist for the initial care and forethought exercised in the bestowal of his spare parts and tools. Motor cars have not always been as well equipped as they might be for the purpose, but every year shows an improvement in this respect, and when buying a car the automobilist can now usually secure one with drawers, boxes, etc., to take his complete outfit. There is one direction in which he should give special attention, and that is that as far as possible such tool boxes and drawers, and even the boot at the back of the car when fitted should be dust-tight. The employment of baize or felt for lining these would, in addition to acting as a dust preventive, prove advantageous in deadening rattle, though, of course, where an outfit is properly and carefully packed no rattle should exist.

The outfit of special drawers under the steps at both sides of the car will prove exceedingly handy. Such drawers possess two disadvantages, however. If secured only by a single lock, and the motorist should omit to fasten the lock before starting, the drawers may gradually shake loose from the road vibration, and perhaps fall out on the road. This could, of course, be got over by the fitting of special clips to hold the drawer in place, apart from the lock. The other draw-back is that when the car is washed, a portion of the water may find its way into the drawers and rust the contents. This, however, can be obviated by removing the drawers before washing the car. These drawers, if properly made and fitting tightly, form handy and inconspicuous receptacles for tools and spares, and leave the rest of the car free for luggage, wraps, etc.

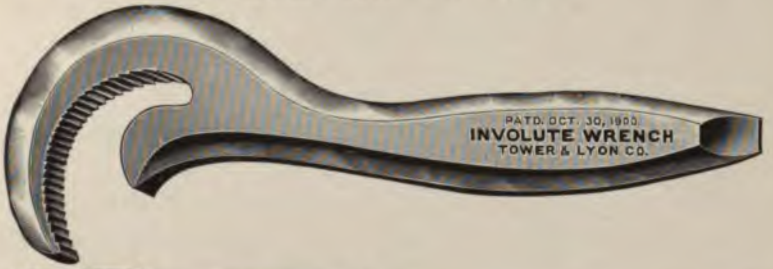
In addition to the felt linings which we suggest above, a good plan is to have spring clips fitted for holding such things as the tire-pump, jack, etc. Gasolene and oil cans when carried, should preferably have a separate space set aside for them in the well under the seats or in the boot at the back, as the case may be. Spare tubes should have their own waterproof bags, and be carefully placed, and if a spare casing is carried, there are tire covers made with compartments in the middle for carrying odds and ends—an admirable device. For the actual tools some really excellent leather kit cases are made. Those of the roll type, with separate divisions for each particular tool, are very handy. With everything so incased, there should be absolutely no rattle from the various accessories.

A most useful, if not ideal, box for holding tools, enables every tool to be seen at a glance, while the different classes and sizes of tools and spare parts are kept entirely apart. It is particularly adapted for use on the footboard, along which, on opening, the trays extend, the front panel acting as a strut for their support. Not only does it separate large and small tools, spare parts from tools, etc. (this can easily be accomplished in a series of drawers), but it effects a most convenient separation, and at the same time shows all tools and spare parts at a glance. Delays caused by searching for the right tool are avoided, and all tools and parts are kept in perfect order, so that one knows at once where a certain tool will be found. It also prevents rattling.

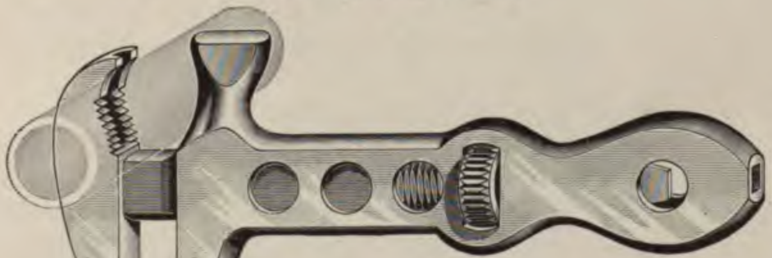
As regards the tools and accessories themselves, we purpose including here a description of a complete outfit for the car and motor house. We shall first deal with the car out-



Tool Bag and Tools—Locomobile.



The Champion Screwdriver.



The Boardman Wrench—Tower & Lyon Company, N. Y.

fit, marking with an asterisk those articles which many owners do not consider essential, and under the heading "Garage Outfit" will deal with articles which could not be conveniently carried on the car or be properly utilized on the roadside. In this case, also, an asterisk denotes those which are not essential.

Care should be taken to replace spare parts that have been used, or inconvenience may result later. It will be found best to carry the smaller articles, such as terminal screws and carbureter fittings, in a separate receptacle. The contents of the tire repair outfit should also be separately carried in a small box, which must be kept away from oil.

THE CAR OUTFIT.

The outfit should comprise the following tools, etc.:

Acetylene Burner Cleaners—These are obtainable from firms supplying accessories. Where the construction of the lamp allows, there may be carried a spare nipple to attach to the underside of the burner bracket, so that the tire pump may be attached to blow any foreign matter clean through the burner.

Blades for Coil—Spare trembler blades should always be bought with the coils so as to insure having the spare tremblers accurately fitted by the makers.

Blow Lamp—Generally used with alcohol, but gasolene can be burned equally well, thus dispensing with the necessity for carrying alcohol. The appliance is used for heating the soldering bit, or the flame may be projected directly onto the part to be soldered. About one-half pint capacity is a useful size.

Bolts and Nuts—Cotters, washers, etc., to fit the most important parts of the car should be carried.

Box Spanner—A box spanner is one which completely encircles the hexagon head of the nut or bolt, and thus prevents damage to it.

Bradawls—These little instruments are useful for making small holes in wood, leather, etc., and turning very small screws. Two or three of different sizes should be procured.

Calcium Carbide—This should be kept in air-tight tins.

Carbureter Fittings—These should include a spare needle valve and a spare wire gauze (where this is used).

Castor Oil—For clutch leather, where the clutch is leather faced.

Cleaning Cloths—A supply of these should always be on the car.

Cold Chisels—A couple of cold chisels, one about 8 inches by three-quarter inch, and the other about 5 inches by one-half inch, should be carried.

Contact Maker or Contact Breaker Spares—A few of the most important small parts of the contact maker or contact breaker should be carried, such as new wipers or new spring blades, whichever type is used.

Copper Rivets.

Copper Wire—Two coils of copper wire, one thin and one thick. It is a most useful material for temporary repairs.

Emery Cloth—A single sheet of each of two or three different grades.

Files—Flat, half-round and round files will be found most useful. Each should be about 8 inches long and provided with a handle, which should be fixed on permanently. The grades should be smooth and "bastard," and a "dead smooth" flat file about 4 inches long should be provided for trimming the platinum points. Two "rat tail" files and one three-cornered will also be found handy.

Funnels—Two should be carried—one for gasolene and one for water. They should be fitted with fine gauze strainers and the one used for gasolene should be fine enough to obstruct the passage of water. A smaller funnel without a strainer should be reserved for lubricating oil.

Hammers—These are indispensable articles on a car. The form used by engineers is the best, having one peen flat and circular, the other peen straight-edged. A useful weight is two pounds. A smaller size with a ball peen is also handy for light riveting.

Helical Springs—A duplicate of every spring on the car (except axle springs) should be carried, especially for the valves and the magneto tappet rods, where these are used. They are sure at some time or other to be wanted.

Inspection Lamp—When it is necessary to work on the car at night a portable electric lamp, or a safety oil lamp, is indispensable. A naked light should never, by any chance, be taken near the car, as there is always a possibility of gasolene being on the ground, which if ignited, would cause a fire.

Insulated Wires—High and low tension. A length of each should be included where coil and battery ignition is fitted.

Insulating Tape—There are two varieties, one plain rubber, the other consisting of rubberized canvas. A supply of each is advisable.

Key—For removing the carbureter jet.

Knife, Clasp—This knife should have two blades of the very best quality, which should be kept sharp. A knife fitted with four or five different tools is of little use on a car.

Links and Pins—These are necessary where chains are used. The spare links as supplied by the chain makers are very handy for this purpose.

Oil Cans—The engineer's type is the best obtainable. Those fitted with a squirt and a non-spilling filler are to be preferred. Flat oil cans of the cycle type should be provided, in which to carry kerosene and gasolene. They should be fitted with a screw top to the jet.

Platinum-tipped Screw for Coil and for contact makers, also for magnetos where used. These should not be forgotten.

Pliers—There is a variety of different patterns of these useful tools, the best of which are the Gas Pliers, which have jaws shaped to grip small cylindrical objects, and the Square-Nosed Cutting Pliers, which are used for general wire work, and have knife edges at the side, with which to cut wire.

Punch—Two flat-nosed round punches, one about 8 inches long, and the other about 5 inches, made of hexagon steel. Also a 6-inch brass punch is useful for punching out cotters where damage to the end would prevent their being used again.

Resin or Rosin—A small quantity should be carried for soldering. See Soldering.

*Rubber Tubing—Assorted sizes and lengths for covering ignition wires and plugs.

Rule—The workshop and the car should each be provided with a 12-inch steel rule, marked on one edge with metric units and on the other with United States units. Its use is obvious. A similar rule, 4 inches long, can be carried in the pocket. The metric system is increasingly used in connection with small machinery parts.

Screwdrivers—Three of these useful articles should be included: one long, one medium, and one small. They should have substantial conical-feruled handles of hard wood. Cheap screwdrivers are no good for car work.

Screw Jack—Care should be taken to get a jack that is designed to take the weight of the car on which it is intended to be used, as if too light it would be likely to collapse. It should also be of suitable range of lift.

Solder—A number of sticks of solder should always be kept on hand. See Soldering.

Soldering Iron—Sometimes called a soldering bit. A square copper bit will be found most useful, and it should always have its faces kept clean and tinned. For particulars of its uses see Soldering.

Spanners—There are several types of spanners, the most useful being the double-ended key spanner, which has a pair of fixed jaws at either end, each pair fitting one standard sized nut. Two or three of these spanners should be carried, with different sized jaws. The Plug Spanner is a tool used for withdrawing caps, such as those fitted for inlet or exhaust valve covers. For the sake of lightness, the cap is hollowed, a projection on the spanner (usually hexagonal) fitting into the hole. It is practically the reverse of an ordinary spanner. The Box Spanner is a tubular piece of metal, shaped at each end to fit a standard nut, a cross pin at the opposite end to that placed over the nut affording a grip for the hand. There are special spanners which enable one to conveniently operate an awkwardly placed nut, save time in operating it, and will fit nuts and bolts for which the standard spanners are unsuitable. One such spanner consists of an ordinary pair of pliers, provided with jaws shaped approximately to fit a nut. This device saves the corners of the nuts from being rounded off by the misuse of ordinary spanners or pliers.

Spark Plugs and Washers—On multi-cylindered cars two spare plugs with their copper washers should always be available.

Tire Outfit—The tire outfit should be made up of the following articles: A foot-pump provided with a set of "adapters"; a pressure gauge, one spare tire casing, two or three spare inner tubes, two sheets of canvas, one single, the other double proof; one set small, medium, and big patches, one set canvas patches, one sheet stout patching rubber, three or four sheets of coarse glass paper, or a six-inch rasp; one tube of rubber solution, one tire sleeve. Tire levers—The usual tools for this purpose are three or four flat plates of steel with slight corrugations at the ends. Special tools to facilitate the removal of valves and security bolts should also be included. (See "Tires" in Repairs and Adjustments.) A portable vulcanizer; a small supply of vulcanizing preparation as sold with the vulcanizer; one tin of chalk (soapstone); one indelible pencil.

Valves—Spare inlet and exhaust valves with their springs, washers and cotters. Where inlet and exhaust valves are interchangeable only one spare valve is needed on the car.

Valve Grinding Powder.—Consisting chiefly of emery or corundum, used for grinding in valves. A small quantity in a tight metal box is useful.

Valve Lifter.—A device for compressing the valve spring to enable the retaining cotter to be easily removed.

*Vise.—When it is necessary to file small pins and screws, a small hand vise will be found useful for holding them.

Volt and Ammeter Combined.—An instrument reading up to 8 volts will be found the best. It is used for testing storage or primary batteries. Only the very best volt and ammeters should be purchased. There are cheap ones, but their readings are generally not strictly accurate or do not long remain so. A tiny four-volt lamp should also be carried for testing purposes.

*Vulcanizer.—The portable vulcanizer is a most useful addition to a car outfit. There are several good ones in the market.

Washers.—Copper and asbestos, and plain steel ones. These should be selected of sizes to fit the principal bolts and unions, and spark plugs or igniters.

Wrench.—A large adjustable wrench, of substantial design, is essential, together with a small motorcycle wrench. The cycle varieties are usually too flimsy to stand heavy motorcar work.

THE GARAGE OUTFIT.

Anvil.—An old 20-pound square casting from a foundry, at a few cents a pound, will be found a useful support on which to rest a job which has to be hammered.

Bench.—A stout bench about 2 ft. 6 in. wide and 2 ft. 9 in. high, with a 2 in. plank top, should be fitted in that part of the garage which enjoys the best light. It should be preferably built into the wall on stout 4x4 in. uprights, with cross bearers, and a few pine drawers for tools. Its length will depend on circumstances. If it is a separately built up bench it should be very firmly attached, preferably to a brick wall, by stout iron brackets. The legs should be firmly attached to, or cemented in the floor, according to the nature of the latter.

Brace and Bits, or Drills.—A tool used for drilling holes in metal or wood. It is advisable to get one of good quality, provided with a chuck that will take various sized drills. Twist drills are the most suitable up to three-eighths inch diameter, as they can be used for either wood or metal. The drills should increase in diameter by one-sixteenth inch, from the smallest size, which should be one-sixteenth inch. Above three-eighths inch it is difficult to get the drill to bite in metal, but holes may be drilled in wood up to one and one-quarter inch with the brace. For this purpose it is best to get an adjustable wood center bit, which bores one-half inch as its smallest size; but it must be remembered that this bit is useless for metal. The brace can also be used to grind in the valves, if provided with a long bit in the form of a screw-driver.

Calipers.—For measuring the diameters of cylindrical objects. A pair of both inside and outside calipers should be obtained that will measure a maximum diameter of 8 inches.

Corundum Stone.—This will be found most useful to provide a comparatively rapid means of sharpening cold chisels, drills, etc. It does not require water.

Chisels, Wood.—Three sizes should be obtained—namely, one-quarter inch, one-half inch, and one inch. Cold chisels are also necessary.

Clamps for Vise.—Lead plates about one-quarter inch thick, folded over the jaws of the vise, are handy to grip finished work, thus preventing the material being marked by the jaws of the vise. Sheet brass will also serve this purpose.

Cleaning Brushes and Sponges.—A set should be kept, free from grease, etc., for the purpose of cleaning the coachwork, together with a set of dusters and metal polish for cleaning the metal fittings. Two good wash-leathers are also necessary, a long poke-brush for washing in corners, and a fairly soft cloth brush for upholstery, known as a furniture brush.

Densimeter, or Hydrometer.—An instrument used for determining the specific gravity of gasolene or the acid in batteries. A fair sized brass one in a long testing glass should be provided. See Densimeter.

Drift.—A piece of steel of rectangular section, used to place between a hammer and a key which is to be knocked out of position; also a workshop tool of long dimension, and with a cross section of any suitable shape. It has teeth cut upon its edges, and when driven into a hole of approximately its own shape, but slightly smaller, it cuts out the sides and leaves the hole the same shape as its section. The operation is called "drifting."

*Drilling Machine.—A drilling machine is not absolutely necessary, as most of this kind of work can be done with the brace or on a lathe. If, however, one is installed, it should have a chuck which will take various sized drills, and should be capable of drilling up to about three-quarter inch and have a fairly heavy flywheel.

*Elevator for Car.—These are rapidly superseding the inspection pit for small workshops.

File Card.—This is used for cleaning files, and is made in the form of thick, felt-like material, studded with short, fine steel wires. The sheet should be cut into strips, about five inches by two and one-half inches, and securely nailed upon pieces of wood an inch thick, and slightly smaller than the card. It is used in the same way as a brush, and is moved along the serrations of the file to remove such materials as solder which have clogged the serrations. It is also very useful for roughing rubber previous to patching.

Fire Extinguisher.—A patent fire extinguisher should be kept in a handy corner in case of fire. Damp sand is very effective also, but water is useless. A sand bin kept full of fine sand and a shovel should be in every garage.

Flux for Soldering.—A quantity of killed spirits should be kept in a stoneware bottle ready for using for soldering. It should have a rubber or stoneware stopper, and should be kept away from steel or iron tools, which it very speedily rusts. Powdered resin in a tin pepper box should also be kept for using when soldering electrical connections.

Grindstone.—A small stone worked by a foot treadle will be found useful and necessary in conjunction with a lathe. It should have a water trough.

Hammer.—A good heavy hammer should be kept specially for garage use in addition to those in the car outfit. One about four pounds weight with flat and ball peens is most suitable.

Hose with Fittings.—A good hose, fitted with brass connections, is essential. If fitted with a special union it can be attached to any water faucet in a moment.

*Lathe.—There is no doubt that one of the most useful tools in a workshop is the lathe, as almost every imaginable operation can be done with it. It should be fitted with a good self-centering chuck and a slide rest. A screw-cutting attachment is also useful, but it is not absolutely necessary. A handy lathe for the motor-car shop has three and one-half inch centers, and should be provided with a good set of lathe tools. A smaller size is very suitable for a private garage.

Oilstone.—A stone of a good variety is always useful. After sharpening a tool on it, all the oil should be cleaned off the stone, as otherwise it will get into the pores of the stone and spoil it.

Saws.—A hack saw, with a set of 9-inch fine blades, is useful for cutting metal. For wood, a 12-inch tenon saw should be kept.

*Shears or Snips.—This tool is used for cutting sheet metal. A medium-sized pair should be procured, that will cut up to about 20 gauge brass.

*Tanks.—A tank for lubricating oil is very convenient, and conduces to cleanliness.

Taps and Dies (with Stock).—A set of taps and dies should be procured which will screw up to five-eighths inch threads, and a small set to screw standard small thread screws.

Valve Truer.—Where a lathe is not available a very handy tool in the garage is a valve truer, by means of which the angles of valves can be accurately re-turned by hand ready for grinding in. The tool is inexpensive, and very efficient ones can be obtained from manufacturers.

Vise.—A four-inch quick-grip vise will be found the handiest tool. Cheap vises are dear at any price.

Waste.—The best white cotton waste should be used for metal work. When at work on the car cleaning cloths are preferable, as bits of waste are liable to get into pipes, etc., and cause troublesome stoppages difficult to diagnose.

Tooth—One of the projecting knobs on the edge of a wheel which engage with corresponding parts of another wheel or other body; a cog.

Toothed Wheel—Any wheel having cogs or teeth. See Wheels; Gear.

Top—A hood or cover for a motor-car. It may be either folding or immovable. A canopy top is one of the latter variety; that is, it does not fold up.

Top Speed, Driving on—See Driving.

Torch—One of various appliances used for lighting. A device for lighting the fuel burners of a steam motor.

Torch, Plumber's—A gasolene torch for heating a soldering iron.

Torque—The turning effects on a shaft or other member causing it or tending to cause it to rotate; the driving pressure exerted on the crankshaft. In a gasolene motor the torque is supplied by the pressure on the piston of the expansion of the gas, which is transferred through the connecting rod and crank pin to the crankshaft of the engine. Were the connecting rod of infinite length, the maximum torque would be given by the product of the pressure of the piston and the length of the crank throw. The torque, however, is constantly fluctuating, and depends entirely upon the obliquity of the connecting rod and the position of the crank at any instant, as well as the varying pressure behind the piston.

Torque Rod or Torsion Rod—In order to prevent the tendency of the back axle casing to turn round, owing to the torque set up on it by the bevel drive, torque rods or torsion rods are used. These are often formed in pairs. They are long rods, one end of the top rod being pivoted to the top of the differential case, and one end of the other to the bottom of the differential case. The rods are brought forward on the chassis, and pivoted some distance away from the back axle on a common pivot, generally to one of the cross members. In some cases where propeller shaft drives are used, the casing which takes the propeller shaft is extended forward and forms an efficient torque rod.

Torsion—The act or effect of twisting. The alteration in the relative position of the parts of any solid, due to rotation about a common axis, as by twisting one end of a wire or rod while the other remains fixed.

Torsion Brake—A species of dynamometer.

Torsion Rod—See Torque Rod.

Tour, Makeshifts on—See under Makeshifts.

Touring—This is the most fascinating branch of automobiling. It is a health-giving pastime which never palls; it gives one a unique opportunity of studying every section of a country, while the lover of scenery can satisfy his inclinations to his heart's desire.

The Car.—The choice of a suitable car is a matter of great importance. It should be strong enough for the varying nature of the roads, and, at the same time, should not be too heavy or the tires will give trouble. To tour with the acme of pleasure it is advisable to have a party, say of four, but here the baggage question sometimes presents a difficulty, though the best modern cars are conveniently arranged to accommodate baggage.

With the side-entrance type of body which has become almost universal, the space available under the back seat is considerable, and it is a simple matter to have a hinged grid behind for carrying baggage. One of the side platforms also can be used for this purpose. With a limousine body there is, of course, ample accommodation on the roof, but the more baggage is piled on top the more is the stability of the car affected. No matter what the size or design of the car, baggage should be reduced to a minimum, for extra weight will not only reduce the speed up hill considerably, but will materially affect the tire bill.

Speed.—The genuine tourist will do comparatively little speed motoring, but will be content to maintain a reasonable average according to the nature of the road and the scenery encountered en route. For this reason the gear should be comparatively low, for, taking into consideration the fact that the best scenery is to be found in mountainous districts, ample power for hill-climbing is very essential.

Equipment.—It is an excellent plan always to carry a well-equipped luncheon basket, containing, amongst other things, a small cooking stove. The time often spent in waiting for unsatisfactory meals makes a sad hole in the best part of the day, and it is often better to select a stopping place in the open air (provided, of course, the weather is fine), and there prepare one's own repast.

Program.—In touring it is always best to have no hard and fast program. One of the great fascinations of motoring consists in the ability to go wherever one feels disposed, and to start and stop at any time that suits one's inclinations. Therefore, only the general outline of the tour should be sketched out. On one day, when the roads are found to be good, and the scenery not interesting, the distance covered might exceed 150 miles, and on another day, where there is much to be seen, 50 miles might be found ample. The automobilist should get rid of the idea that pleasure is to be measured by the mile instead of by the hour. It is well, also, to stop a day or two occasionally at attractive resorts, where one can vary the program by yachting, boating, fishing or such like amusements, while the car is being thoroughly overhauled. To rush on day after day without an occasional stoppage for a thorough overhaul is very severe on the car, and really does not afford much pleasure in the end to the tourist.

Caution.—When touring in unknown mountainous districts one should exercise a reasonable amount of caution. Very often the hills are so exceptionally steep as to be positively dangerous except for a car with ample horse power, a reasonable gear, and perfect brakes. If the driver has any doubt as to the capability of his car to ascend any really dangerous hill he should run it backward, as in this position he will be much safer should the engine prove unequal to the task set it, and, in any case, the car is more likely to reach the top, as the reverse gear is always lower than the low speed forward.

In descending steep and unknown hills, one cannot be too cautious. The margin between complete control and absolute helplessness is often much less than the driver imagines, and a slight increase in speed beyond what is judicious may make it impossible to turn a sharp and unexpected corner. If either brake is inoperative or weak, steep hills should be descended at four or five miles an hour, so that in case of a failure of the other brake the car could at once be swung square across the road. Even if a slight collision with a wall or bank does occur, little damage will be done, provided the obstacle is struck squarely, whereas a genuine run-away on a bad hill generally ends seriously. In descending really dangerous hills, needless to say, the first speed should be put in operation, and the driver make use of the engine to assist in keeping the car under control. See Driving.

Overhauling.—It is a good practice when touring to see that the car is overhauled immediately on the completion of the day's run, and that it is left in absolute readiness for the following day's journey. (See Overhauling.) If this is made a uniform habit, it will save much inconvenience and delay, because very often when a start is made to clean and overhaul the car, it is discovered that much more is necessary to be done than was at first imagined, and if the work is left over until the morning either the start will be delayed or some important adjustment will be postponed at the risk of causing injury. It is seldom safe to trust hotel help to wash down and clean the car. One never knows what damage may be done, especially if they attempt to take the bonnet off to get at the engine. If the owner has not got his own chauffeur with him, and the hotel people's services are requisitioned, he had better stand by to see the work done. Also, it is advisable to see that the car is put under lock and key during the night, or some of the valuable accessories may be removed.

Camping.—The motor car lends itself especially to that most delightful form of Bohemian holiday-making, "camping." One is quite independent of hotels, and can wander where fancy directs and select one's own stopping place. Rarely, if ever, is there any difficulty in finding a suitable site, and permission to pitch the tents is easily obtained when necessary. Nowhere does one sleep more soundly than under canvas, while as regards colds or rheumatism few habitual campers are troubled by either.

The outfit is simple. For a party of two or three it should include two small waterproof tents, some soft rugs, which on cold nights can be supplemented by the car rugs, and two thin waterproof sheets to keep out the damp. A waterproof car rug will do admirably. A small oil stove, with the necessary pots, pans, plates, cups, knives, forks, etc., should be carried for cooking purposes. A special light outfit designed for the purpose of camping can be procured from manufacturers.

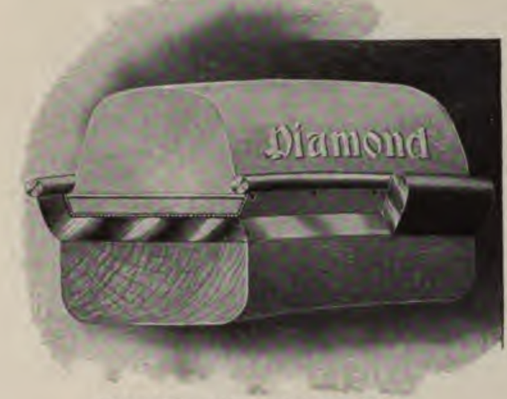
A dry, slightly sloping, sheltered site should be selected for pitching the tents. The thin waterproof sheets should be stretched on the ground, and straw, hay, ferns, or such like spread over it to a depth of at least a foot. Straw is the most comfortable. The car rugs with the waterproof side downward should be laid on top. A more comfortable bed it would be hard to find. A spare blanket or rug should be laid alongside the sleepers, for it invariably becomes colder just before the dawn.

There is one point of vital importance. The tent door should be left partially or wholly open under all circumstances. Even if the wind blows right in it will never cause a cold, whereas if the tent is closed the air will become so foul that the inmates will sleep badly, and in all probability catch cold. It is foul air and local drafts (as distinguished from a full volume of air) that cause colds in 99 out of 100 cases.

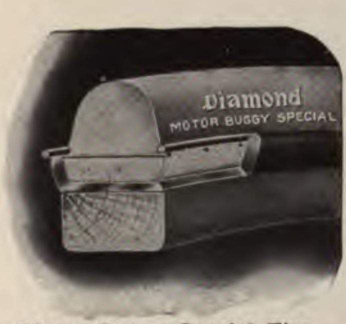
Should the day turn out really wet it will be found advisable in most cases to put up at a hotel for the night. Many automobilists, however, have frequently braved the elements under such circumstances, and never suffered any ill-effects.

Permission can nearly always be obtained to leave the car in a neighboring stable or barn.

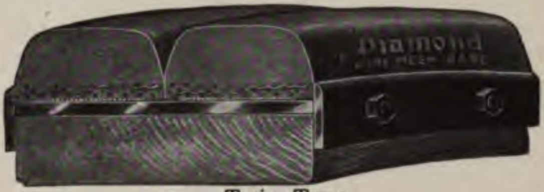
As regards fishing, motoring and camping fit in admirably. Fishing is generally "off" when the weather is bright and dry —in fact, just the time when motoring can be most keenly en-



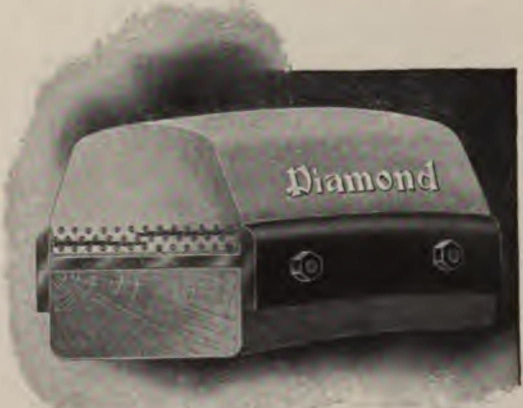
Side Wire Type Motor Tire.



Motor Buggy Special Tire.



Twin Type.



Diamond Wire Mesh Base Motor Truck Tires.
(The Diamond Rubber Company, Akron, Ohio.)

joyed. On the other hand, when the weather is showery, and comparatively dull, fishing is often at its best. The touring fisherman can, therefore, drive through the country as long as the weather is favorable for motoring, and, whenever opportunity occurs, pitch his tent in the neighborhood of a river or lake, and fish to his heart's content.

Touring Accessories and Tools—See Care of Car on Tour.

Touring Car—This term is generally applied to a car having an open body, which may be fitted with a top, and seated for from five to seven persons. See Touring.

Touring, Care of Car While—See Care of a Car on Tour.

Touring Outfits—The prospective tourist is apt to carry much that is not needed and to leave at home several essentials. Much depends upon the extent of the tour in order to determine what is needed and what can be left at home. Modern cars are fitted with so much carrying space that it would seem good sense to take a few unnecessary articles rather than leave at home some essentials. The following list will serve as a guide from which to select before starting on a tour of almost any extent:

Casings, at least two, which should be fitted once or twice to the rims in order that a quick repair may be made on the road.

Tubes, at least four, in good condition.

Chains, four. It is not safe to drive over unknown, rough and muddy roads with chains only on the rear wheels. Once a motorist has used four chains on a bad road, he will never be satisfied with only two.

Valves and springs, one each exhaust and inlet, with extra springs. Where valve cages are used, two complete cages.

Air tank and a good pump, the latter for emergency.

Tire repair kit, with a liberal supply of fabric, patch rubber, cement and soapstone.

Oil, conveniently arranged so it will not spill; sufficient to carry the car a hundred miles or more.

Litharge and glycerine, to repair radiator or other similar leaks, as described elsewhere.

Rubber hose, to repair leak in gasolene line temporarily or replace hose on gas lamps.

Spring clips, to make repairs in case of broken spring leaf.

Rubber coats, rubber blankets, rubber hat.

Tools—Wrenches, hammer, pliers, hand-vise, hack saw, pipe wrench, cotter, three or four files, punch, assorted drills, and stock.

Wire—Spool soft copper wire; roll stovepipe wire.

Cotter-pins.

Nuts and bolts in small assortment such as are used on car or motor.

Small emergency surgical kit.

Carbide and extra tips for gas lamps.

Tire tools.

T-plate—A metal plate shaped like a letter T.

Track—A course laid out for races; a speedway for automobiles, etc. The mark left in a roadway by the wheels of a vehicle.

Tracks, Speeding and Racing—Special tracks or courses for speeding and racing motor cars have been prepared or reserved by municipal authorities, automobile clubs or associations and private persons in many parts of the United States. One of the best known of these is the seaside track at Ormond Beach, Florida, the scene of many notable contests. Numerous speedways, particularly in the Eastern States, afford an opportunity for automobile owners to test the speed qualities of their cars without fear of infringing the law and the tendency toward increasing the number of such special driveways is gradual but certain.

A new and unique speeding track is found at Tarpon Beach, between Galveston and Tampico, Texas. Here, it is claimed, automobilists will find the finest and longest straightaway course for automobile speeding or racing in this country, if not in the world.

This beach track is 90 miles long with almost imperceptible curves. It is from 100 to 300 feet wide, almost as hard as cement and almost entirely free from obstructions, such as logs, driftwood, etc. An enthusiast writes: "No coast can match this magnificent beach, which, beginning just above the Pass, extends north for 90 miles, as firm and as clean as though a linoleum covering had been spread there for the delight of the public. One can start in an automobile at the south end and travel the entire ninety miles over a beach as firm as the best asphalt roadway, with a delightful gulf breeze fanning his cheeks."

Mr. W. K. Vanderbilt, Jr., donor of the Vanderbilt Cup, is understood to be financially interested in this Gulf beach and efforts are being made to hold the Vanderbilt Cup Race and other contests there.

Tracks, Street-car—In places where there are street-car lines the tracks constitute a source of danger to the automobilist, though more particularly to the motorcyclist. The only advice that can be given is to always cross them at as great an angle as possible, and never to get into a track, if avoidable by any means. If a motor bicycle gets into a track a spill is likely to result if the line is at all wet. With a car, if the wheels get into a greasy track, considerable strain is thrown on the axles. To get out, the driver should give a quick, sharp turn of the steering wheel, and if the car does not come out at once, he should let the wheels straighten into the line again, and then make another attempt. When the car does get free it is apt to come out with a swerve, which is very dangerous if there are vehicles approaching.

Traction Wheel—A wheel which draws or impels a vehicle, as the driving-wheel of a self-propelled vehicle, to which power is applied. Its frictional adhesion to the surface on which it bears is the direct agent of progression.

Tractive Coefficient—The power required per unit of mass to move a car at a constant speed on a given surface. Generally expressed in foot-pounds per ton.

Tractor—That which draws or is used for drawing, as a motor car which draws other vehicles.

Trade Papers—The periodical literature of the automobile is both interesting and valuable. The papers published in the interest of manufacturers and owners of automobiles are second to none in enterprise and give a weekly or monthly presentation of motor-car developments which is well worth study by motorists who wish to be well informed. The following are the leading journals published in the United States and Canada which deal with the automobile industry, trade and pastime:

Weekly.

New York.—Automobile and Motor Review, 395 Liberty street; Automobile Topics, 401 Times Building; Horseless Age, 147 Nassau street; Motor World, 154 Nassau street; Bicycling World, 154 Nassau street.

Chicago.—Motor Age, 309 Michigan avenue; Motor Way, Kenfield Building.

Cleveland, Ohio.—The Power Wagon.

Semi-Monthly.

Providence, Rhode Island.—New England Automobile Journal.

Monthly.

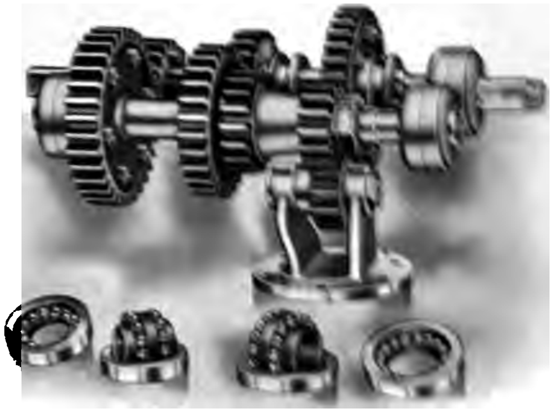
New York.—The Automobile, Flatiron Building; Automobile Dealer and Repairer, 27 Park Place; Commercial Vehicle, 1535 Broadway; Motor, 1789 Broadway; Motor-Cycle Magazine, 154 Nassau street; Motor-Cycle (illustrated), Drexel Building; Automobile Magazine; The Hub; The Motor Car.

Philadelphia.—Cycle and Automobile Trade Journal, 1213 Filbert street; Motor Print, 408 Sanson street; Motor Vehicle Register.

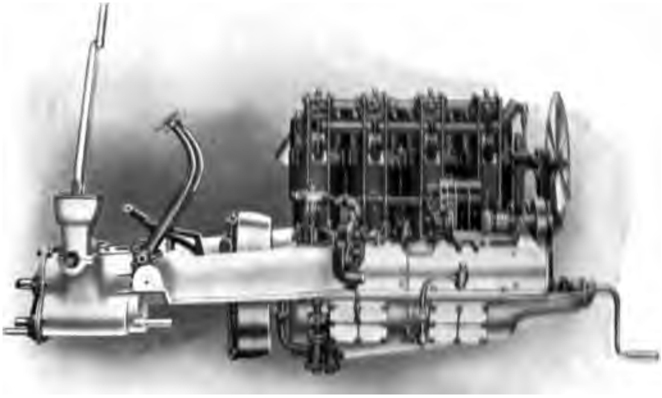
Cleveland, Ohio.—The Automobile Builder.

Detroit, Michigan.—Motor News.

Atlanta, Georgia.—Southern Automobilist.



Knox Model "O" Transmission Gears, Shafts and Bearings.



Knox Model "O" Power Plant—Water Cooled.

San Francisco, California.—Toot Toot.

Los Angeles, California.—Pacific Motoring.

Denver, Colorado.—Motor Field.

Newark, New Jersey.—Auto Bulletin.

Toronto, Ontario.—Canadian Motor; Motoring.

Woodstock, Ontario.—Rod and Gun and Motor Sports in Canada.

Trade Purposes, Motor Cars for—See Commercial Cars.

Traffic, Driving Through—See under Driving.

Trailer—A vehicle drawn by another connected with the source of power and called the tractor.

Train—A set of wheels or of wheels and pinions in series, through which motion is transmitted consecutively. A set of rolls used in metal working.

Train Balladeur—See Balladeur.

Train of Gearing—See Train.

Transformer—Another name for an induction coil or a converter. See Coil; Converter.

Transmission—The term "transmission" applies strictly to the whole of the mechanism employed in transmitting the power of the engine to the periphery of the road wheels. The different systems of transmission are dealt with under Motor Car, while for the details of the separate units of the transmission mechanism see Clutch; Change Speed Gear; Chain; Axle (live); Gear; Differential, etc.

A comprehensive article on the subject will be found under the sub-heading "Transmission and Variable Gear" in Change Speed Gear.

A typical modern system of transmission in a chain-driven car is described as follows:

"The power of the motor is transmitted to the driving mechanism by means of a cone clutch. The apparatus is very simple and only a few parts are needed; it acts promptly and positively and there is no drag in changing gears, power being completely cut off when the clutch is disengaged. Ample frictional surface is secured by means of a wide strip of leather riveted on the face of the clutch, and flat springs are placed at intervals underneath the leather, so that when the clutch is engaged with the flywheel, the car starts smoothly and gradually. The pressure of two strong coil springs causes the clutch to be normally engaged with the flywheel and the pressure of these springs is overcome by a pedal operated by the left foot.

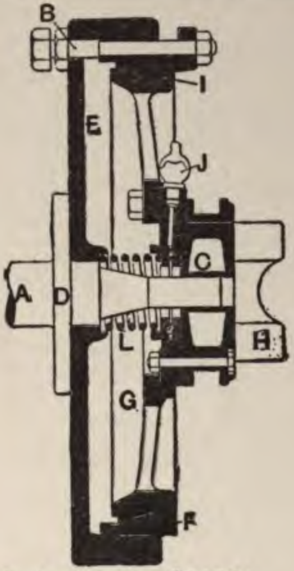


FIG. A.—SECTION OF INTERNAL CLUTCH.

A, engine crankshaft.
B, clutch-adjusting bolt.
C, sleeve carrying inner or movable part G.
D, crankshaft flange.
B, flywheel.
F, ring bolted to flywheel.
G, inner part of clutch.
H, driving jaw of clutch.
I, clutch leather.
J, lubricator.
L, clutch spring.

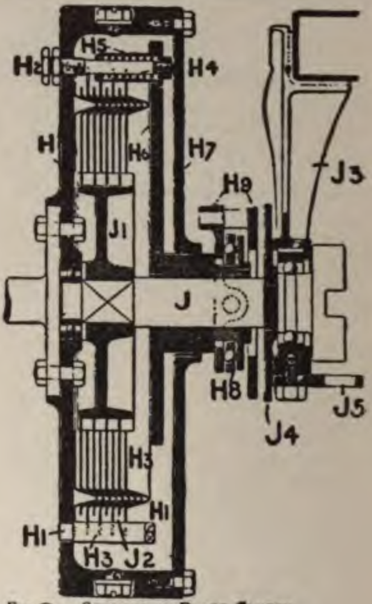


FIG. B.—SECTION OF PLATE CLUTCH.

H, hollow flywheel
H1, driving guide pins.
H2, screwed pins adjusting H4.
H3, driving disks.
H4. clutch springs.
H5, spring cases engaging with H6.
H6, Three-armed spider, controlled by H 9.
H7, cover (oil tight).
H8, ball thrust bearing.
H9, clutch fork mechanism.
J, shaft.
J1, driven member (externally toothed casting).
J2, slotted disks engaging with J1.
J3, bracket.
J4, brake flange to J.
J5, stay bracing to J3.

"The clutch is perfectly self-contained when engaged and there is no end thrust on the motor or gear-box; when the clutch is withdrawn the thrust of the coil springs is taken up by a thrust ball-bearing placed on the tail shaft or rear portion of the crankshaft, and this construction permits the crankshaft to revolve and the clutch to remain stationary.

"A flexible joint, perfectly universal in action, is interposed in the driving shaft between the clutch and the gear-box and this maintains correct alignment between the clutch and the flywheel when the car is traveling over rough roads; it also facilitates the removal of the clutch, should it be desired to do this at any time. The universal joint is constructed of forgings, the wearing surfaces being hardened and ground. A short shaft, or removable spool, is placed between the gear-box and the universal joint for convenience in demounting any of the parts of the transmission mechanism.

A, engine crankshaft.
BB, flywheel forming outer part of clutch.
C. clutchshaft.
EE, arms attached to clutch sleeve P carrying the clutch segments FF.
F_1 F_1, lugs on the ends of the segments FF.
GG, right and left-handed screws, engaging in the lugs F_1.
HH, arms attached to the screws GG.
H_1, H_1, links connecting HH to J.
J, sliding sleeve on clutch sleeve P, actuating clutch.
P, sleeve carrying the arms EE.

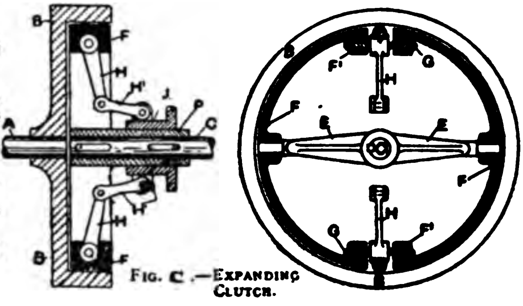
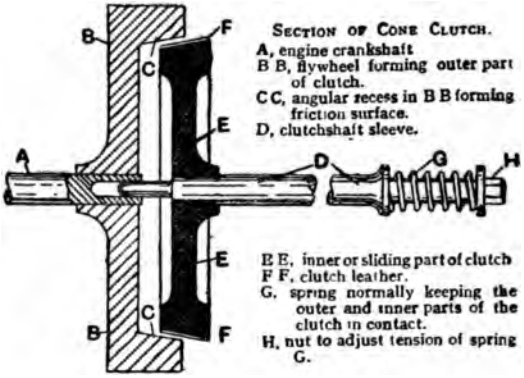


Fig. C.—Expanding Clutch.

"The gear-box is placed near the center of the pressed-steel frame and is secured thereto by strong heavy bolts, the connections being made in the most substantial manner possible. This location of the gear-box is desirable because it does not subject the gears or differential to road shocks. The use of manganese bronze for the gear-box casting insures great strength and rigidity.

"Inasmuch as the car (Locomobile) is driven practically all of the time on the high speed or fourth gear, the power is transmitted directly to the driving bevel gears, no intermediate gears being used; from the bevel gears the power passes through the countershaft to the front sprockets and thence to the rear wheels by strong roller driving chains of the best quality. Much attention has been given to the details of the double side chain drive in order that the mechanism may operate quietly and the adjustment and wear be reduced to a minimum.

"The transmission case contains the gears, shafts, bearings, and also the differential gear, a quantity of non-fluid oil being carried in the case which effectually lubricates all working parts. A vertical standpipe placed in the case enables the operator to insert the correct quantity of non-fluid oil. The use of ball-bearings in the gear box saves room, eliminates friction and permits the use of short shafts."



SECTION OF CONE CLUTCH.
A, engine crankshaft
B B, flywheel forming outer part of clutch.
C C, angular recess in B B forming friction surface.
D, clutchshaft sleeve.
E E, inner or sliding part of clutch
F F, clutch leather.
G, spring normally keeping the outer and inner parts of the clutch in contact.
H, nut to adjust tension of spring G.

Gear-drive transmission is fully dealt with under the headings referred to above.

Transmission, Bind on—See under Loss of Power.

Transmission, Power—See Transmission and Variable Gear, under Change Speed Gear; also Gear or Gearing.

Transverse Shaft—See Shafts.

Trap Valve—A clack valve, or one consisting of a single flap hinged at one edge.

Travel—In machines, the limit of a reciprocal stroke of any part, as the travel of a piston.

Tread—That part of the tire of a wheel which comes into contact with the ground. In order to avoid side-slips and skidding, and in some cases to give a better grip of the road, various kinds of treads other than those which are quite smooth have been adopted. Some of these are detachable from the tire, others form a composite part of the tire itself. Thus we have in the first case leather treads fitted with steel studs and attached to the tires by different mechanical means; while in the latter case we have various conformations of the rubber tread of the tire itself, such as transverse corrugations or grooves, circumferential grooves, high upstanding walls with circular indentations, the Goodrich circular upstanding studs, formed in one piece with the rubber of the cover; the combination of transverse and circumferential grooves, and in some tires metal studs inserted and vulcanized in the tire itself. Sometimes also alternating metal and rubber studs are used. See Tires.

Treating a Burst Tire—See Care of Car on Tour; Tires.

Trembler—The flat spring used in coils and in contact breakers in order to make and break contact. The term is also sometimes used to describe the flat spring used in the positive type of make and break, although in this case it does not actually vibrate. See Coil; also "The Coil," under "The Ignition" in Repairs and Adjustments.

Trembler Coil—A coil with a trembler for making and breaking contact, as distinguished from the non-trembler coil which is used where a trembler contact maker is adopted. See Coil; Ignition.

Trembler Coil Theory—See under Ignition.

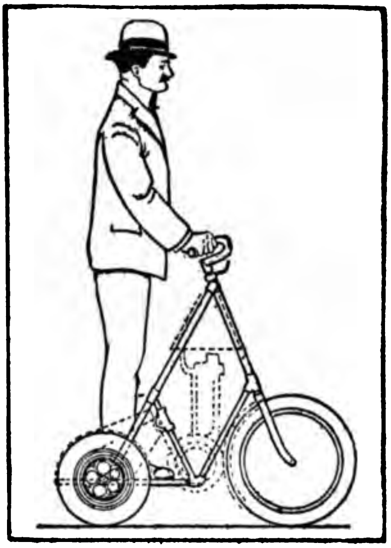
Trembler Contacts, Pitting of—See under Ignition.

Trembler Contact Treatment—See under Ignition.

Trembler Fatigue—See under Ignition.

Tricar—A term which originated from the word "tricycle," and which is generally understood to mean a motorcycle with three wheels and to seat two passengers. Generally, this is arranged by adopting a motor bicycle and substituting for its front wheel a pair of wheels and a fore carriage, when the vehicle becomes a three-wheeler and is called a tricar. The increase in power and the fitting of free engine clutches and variable gears to these machines has resulted in their becoming almost three-wheeled cars, instead of partaking in any way of the nature of a cycle. See Motor Bicycle.

Tricycle—A three-wheeled cycle—sometimes propelled by a motor.



THREE-WHEEL MOTORCYCLE.

A Style Proposed for Short Distance Riding.

Trig—Anything placed under a wheel, etc., to prevent its rolling; a skid; a brake-shoe for a wheel to ride upon in descending steep hills.

Trip, Trippet, or Trip Lever—The term is used in low tension magneto ignition to describe the lever or lifter which slips over the end of the striker and so enables the spring actuating it to release the contacts sharply. See Ignition.

Trippet—A part designed to strike another at regular intervals; it may be a cam, lifter, toe, wiper or foot. See Trip, above.

Trip Rod—Same as Tappet Rod.

Tripoli—A silicious stone, also called rottenstone, extensively used as a polishing powder.

Troubles—See Repairs and Adjustments; also Miscellaneous Roadside Repairs; Missing Explosions; Motor Stopping; Loss of Power; Overheating; and hints and tips under Carbureter, Driving, Engines, Ignition, etc.

Following are the views of a few well-known manufacturers on the general causes of motor car troubles, as expressed to Motor Age. It will be seen that carelessness on the part of drivers is regarded as the root of all evil.

INATTENTION TO OILING.

There is no doubt that the most common fault of automobile users in handling their cars, whereby they have unnecessary trouble, is, without going into detail, lack of attention to lubrication, which causes more trouble than anything else.—Cadillac Motor Company, Detroit, Mich.

"LOOKING FOR TROUBLE."

We can say of a surety that the indifference of the average owner's attention to his machine at other than the times when it is in trouble, is the most notable cause of trouble. The man who keeps the mechanism of his car clean, the bolts tight and the tires free from grease and oil will be the one to appreciate a good car, the true value and sport of motoring, and the one whom his neighbors will call "lucky with his automobile." Contrary to the old adage, the motorist should cross the bridge before he gets to it. He should hunt for and anticipate trouble on the principle of a stitch in time saves nine. Inattention and careless neglect causes more after trouble and embarrassment than downright ignorance or inexperience. There is some excuse for the latter but not for the former.—Dolson Automobile Company, Charlotte, Mich.

MORE "HORSE SENSE" NEEDED.

In the old bicycle days we once brought out a special 19-pound Columbia, built and equipped especially for road racing. It was intended to fill that specific function, and our salesmen were instructed to discourage the sale of it for ordinary riding purposes. As soon as the riding public learned of the existence of this model the demand increased and we finally found ourselves selling to general riders, despite our knowledge of the machine's limitations.

Once a customer entered our Boston branch, purchased one of these bicycles, mounted it in the store and rode from there to the street, dropping 5 or 6 inches from the door-sill to the sidewalk and nearly double that distance from the curbstone to the street pavement. The man weighed not less than 180 pounds. In the early days of a certain automobile manufacturing company there occurred an amusing experience. A prominent man in one of our large New England cities became interested in the product of this new company; he had a chauffeur study at its factory, and finally purchased a first-class car, which he drove with great delight and success for about a week, at the end of which time he called up the factory on the telephone and explained to the manager that his car was out of service and he could not move it from the garage. After a quick consultation the manager agreed to go directly to the garage and examine the machine, which he felt ought to be in prime condition. On looking over the car everything seemed to be all right until he got to the brakes, and he found all these so closely fastened that the car could not move. He released the brakes, opened the throttle and started away without difficulty. We have had cases where men have tried to drive a machine without any gasolene in the tank and wondered why it would not go, often blaming the car.

Of course these are extreme criticisms, but it naturally leads one to the conclusion that if people would use a fair amount of "horse sense" in the handling of a mechanical device there would be much less trouble and fewer repairs. There are certain things about a motor car that should be watched. It certainly is not rational to drive a machine without the proper equipment of fuel, electricity and oil. If the fundamentals were looked to, the minor affairs might be neglected without causing any very serious results.—Pope Manufacturing Company, Hartford, Conn.

NEGLECT REQUIREMENTS.

Troubles arising from the user's fault are, easily, due to neglect of the requirements of the car. To know that the ignition system is in perfect order, that the gasolene is of the proper test and providing a suitable mixture through the carbureter; that the water circulation is good; that the valves and bearings throughout are in good shape; that the car is properly oiled and receiving replenishment while running, and to operate the car always within its capacity, is to insure against trouble. To neglect any or all of these points or others, is to invite trouble—is the user's fault. Wonderful long-distance and non-stop runs have been accomplished simply by expert attention to these requirements of the car and not by any special device or construction.

Neglect of the requirements of the car is usually due to lack of understanding, and, for this condition, the manufacturers, their agents and salesmen are not entirely free from blame. In selling, stress is laid on the ease with which cars can be cared for and the scarcity of places to oil, etc. The user may conclude that oiling is unimportant and leave it out, regarding his car, not as a machine, but as a carriage. The remedy is to educate the user and impress upon him the importance of oiling, cleaning, general care and adjustment; and when the user looks after and carefully attends to these requirements of the car there will be very little trouble in its proper operation due to the user's fault.—Peerless Motor Car Company, Cleveland, Ohio.

RECKLESS DRIVING.

There are so many improper methods of handling an automobile that it is difficult to specify those that are most harmful. We should name the following as being, in their order, faults that bring fit retribution: Reckless driving; rash manipulation of clutching, gear-changing and braking levers; delayed lubrication.—Sturtevant Mill Company, Boston, Mass.

Troubles, Gear Changing—See under Change Speed Gear.

Troubles with Batteries—See under Battery; Repairs and Adjustments.

Troubles with Coils, General—See under Coil.

Truck—A heavy wheeled vehicle for the conveyance of freight. Auto-trucks or motor trucks are in increasing use in the commercial world. See Commercial Cars.

Trucking and Delivery with Electric Vehicles—For the convenience of those interested in such details a table of comparative capacities and standard dimensions of the electric freight vehicles made by the General Vehicle Company of New York is given below:

Capacity	350 lbs.	1000 lbs.	2000 lbs.	2 tons		3½ tons		5 tons	
Type of vehicle	Delivery Wagon	Delivery Wagon	Express Wagon	Express Truck		Freight Truck		Slow Freighter	
				High Seat	Low Seat	High Seat	Low Seat	Best Truck	Standard Truck
Speed in miles per hour	14	11	10	8½	8½	7	7	6	6
Mileage travel on one charge	50	40	40	40	40	35	35	30	30
Wheel base	70"	83½"	102"	111½"	111½"	125"	125"	129"	142"
Gauge	50"	55"	60"	61"	61"	65"	65"	66½"	66½"
Overall length	114"	126"	150½"	181½"	166½"	199"	184"	203"	215"
Overall width	60"	67"	72"	74½"	74½"	79"	79"	79"	79"
Clear loading space width	35"	41"	48"	36"	56"	60"	60"	72"	72"
length	45"	72"	96"	130½"	120"	156"	137½"	167"	180"
height	43"	60"	68"	72"	72"	72"	72"	72"	72"
Height of platform loaded	36"	31"	33½"	42"	42"	40½"	40½"	41½"	41½"

Truing Parts—A sudden strain or shock is very apt to bend sundry parts of a motor car which it is essential should run true, with the result that, instead of revolving in a true circle, the strained parts describe an ellipse or part of a helix, putting a very great strain on their supports. This out-of-true condition is liable to increase and cause a breakage if allowed to continue.

In most cases the eye is able to trace any unevenness when the part is moving, but in order to find the exact place that has become strained, it is necessary to place it in some position, such as between the centers of a lathe, where, by means of a stationary marker, the direction in which the straightening is to take place can be determined accurately. If a piece of chalk is held steadily, and gradually approached to the part revolving in the lathe, it will first touch and mark the points nearest. These must be first straightened, and the same process repeated till the chalk touches evenly all round.

If a wheel appears to run crooked, raise the car on a jack till the wheel clears the ground, spin the wheel, and approach a block on the ground till the side of the rim just touches. If the rim touches the block evenly all round it is not untrue, but if it swings away from the block at any point it will show it is running unevenly, due to the wheel or axle being strained.

The truing of any revolving part which has to take a weight or considerable strain should be very carefully done, as the metal may become crystalline, and may subsequently break off short. It is best, therefore, to put the job in the hands of an expert and in any case it is necessary to heat the part before straightening it. In the case of wooden wheels, if these get out of true other than at the hub, it is necessary for them to be fixed up by a wheelwright, and to have their tires or tire flanges shrunk on again. In the case of wire wheels, a skillful wheelmaker will be able to true the wheel by a judicious manipulation of the nipples which secure the spokes in the rim, but this should not be attempted by a novice, otherwise he may seriously injure his wheel and cause it to be considerably weaker than previously.

Truing up Blade Contact—See under Ignition.

Truing up Contact Screw—See under Ignition.

Trunk Piston—See under Piston.

Trunnion—The term applied to a bearing upon which oscillation takes place, and not a complete rotation.

Try-cock—See under Cock.

T-Square—A trying square formed in the shape of the letter T, the vertical portion being the blade, the transverse bar the stock; used in mechanical drawing.

Tube-drawing—The forming of tubes by drawing them down from thick cylinders.

Tube, Fire—See Tubes below.

Tube Ignition—See Ignition.

Tube, Inner—The inside rubber tube of a pneumatic tire, inserted into the outer casing and inflated through a valve.

Tube-plate—A flue plate in a steam boiler.

Tube, Platinum—See Tube Ignition under Ignition.

Tube-plug—In steam engines, a plug for driving into the end of tubes when burst by the steam.

Tubes—The tubes for boilers are made of either steel or copper, bent or straight, to suit the boiler; the weight, size, and internal diameter depending upon the size, length and shape of the boiler, and the steam pressure it has to carry. The two principle types are fire tubes and water tubes. In the first the heat passes through the tubes, and the water circulates around them; in the second the water is in the tubes and the heat circulates around them. See Motor Car.

Weldless steel tubes were formerly much used in the frames of motor cars, but stamped steel frames are now general.

Copper tubes.—These are generally used in motor car construction for water, oil and gasolene pipes, owing to their being easy to manipulate and not liable to fracture. Platinum tubes were used in the now obsolete tube system of ignition.

Tubes, Clogging Gas—The small copper tubes commonly used for connecting the generator and the lamps rapidly clog, and in the course of a season or two they require attention. Most of this clogging will be found to take place at the ends and wherever moisture can accumulate. Water in any part of the pipes is a great annoyance, as it causes flickering of the lights, and the piping should throughout be arranged to drain the pipes toward one or both ends. It is better and generally easier to drain back to the generator, but in case this cannot be arranged the forward ends of the pipes may be cleared of water by disconnecting the rubber tubes and blowing through with a tire pump. Pipes found to be clogged may frequently be saved by cutting off an inch or two from their ends. Occasionally this results in small explosions, due to detonation of the acetylide of copper which generally forms in the pipes, and it is well to keep one's eyes and fingers out of range of the ends of the pipes while the sawing or cutting is going on. A few car makers use a larger than standard size of tubing for this work, the aim being to avoid clogging by small particles. This aids matters wonderfully. A few repairmen clean these pipes by forcing water back and forth through them, which is correct, provided proper means are followed to get the water well removed from the pipes after the cleansing operation is completed.—Motor Age.

Tubing—A length of tube, series of tubes, or material for tubes. See Tubes.

Tubing, Hammering out Dents in—See Dents in Tubing.

Tubing Machine—A machine for making or "drawing" tubes or pipes.

Tubular Spokes—The demand for wheels that, retaining the solid appearance of the genuine artillery wheel, shall yet possess the attributes of lightness and strength, has led to the production of wheels built of steel tubular spokes. These wheels are very light and strong, and are sometimes used by heavy vehicle builders.

Tubular Frames—See Frame.

Tumbler or Tumbler Block—A species of lever. As used on motors, it is usually square-sided or of a triangular shape, according to the purpose intended. It is used in the former pattern for actuating the ignition gear of a multi-cylinder motor, the series of edges acting as cams for establishing a circuit path for the electric current. In the latter style a variation of both the tumblers is used to impart a reciprocatory motion to arms, levers, bell-cranks, and the like, or any similar purpose where a short movement of the positive and intermittent sort is required. The principle of the tumbler is very often used in electrical switches to allow of a positive and quick break.

Tundish—An archaic English name for a funnel.

Tungsten—A metal of grayish-white color and considerable luster, brittle, nearly as hard as steel and less fusible than manganese. Used as an alloy of steel and for making lamp filaments. Sometimes called "wolfram."

Tuning up a Car—The term used to denote the process of getting a car to give its highest efficiency in every respect. No two cars, even if built of the same materials, of interchangeable parts, and in the same factory, will give exactly the same results in actual use on the road.

In order to get the best results for purposes of racing, trials, competitions, and general efficiency, it is necessary when cars are first put on the road that they should be "tuned up."

"Tuning up" is a process which cannot be definitely described. It consists in making adjustments in every part of a car so as to get better results; thus, the operator will see that the ignition is in the best possible order, that it is working well and giving absolute synchronization on all cylinders. He will arrive at the best condition only by continual practice with the car. The timing, both as regards the ignition and the valves, may require very minute adjustment, all of which will affect the power given out in the flexibility and general efficiency of the machine.

He may find that he can get better results with a variation of the gasolene spraying nozzle, an alteration in the air orifice of the carbureter, various adjustments to the spring-controlled extra air valve (where such is fitted), or variations in the tension of the extra air valve spring or its equivalent.

Then, again, attention to such parts of the mechanism as the clutch or the lubrication of the gears, will all come in under the general head of "Tuning Up," and it may be safely said that a car will not give the best possible results until it has been run on the road and carefully watched and tuned up in this way for some considerable time. It is a custom with manufacturers to employ skilled mechanics to "run out" new cars and make these various adjustments before they are fitted with the body, thus insuring that they are efficient when delivered to the customer. Even after this has been done, the driver himself may find it advisable to make certain little alterations which may be rendered necessary owing to the variations in the country over which the car has to be driven, or the idiosyncrasies of the driver himself.

Turbine—A wheel that rotates horizontally on a vertical shaft; originally a water-wheel impelled by the impact or reaction of a flowing stream of water, or by impact and reaction combined. In the modern water-propelled turbine a very large proportion of the potential energy of water is converted into work while passing through the wheel.

A steam turbine is a turbine driven by steam jets which impinge upon vanes or buckets on the periphery of a rotating disk or cylinder. It is now in common use and competes in economy of operation for various purposes with the standard types of steam engine. Turbine marine engines are now in successful operation on the largest transatlantic steamships. It is also understood that steam turbines have been successfully experimented with for motor car use.

Turbine Dynamometer—A form of Prony brake adapted for application to horizontally revolving wheels on vertical shafts. It is used for testing the horse-power delivered from turbines, etc.

Turnbuckle—A device, often in the form of a swivel link, for coupling and tightening two parts of a metal bar; a right-and-left screw coupling. A pipe turnbuckle is a right-and-left pipe coupling.

Turner-Miesse Steam Car—See under Steam Cars.

Turning—The operation of shaping objects in a lathe with cutting-tools.

Turning Corners—See under Corners.

Turning Corners, On—See under Driving.

Turnscrew—A name sometimes given to a screwdriver.

Turntable—A turntable is useful in turning a car in a garage where the accommodation is limited, or where the garage is of an awkward shape and cars have to be turned round sharp corners. It consists of a circular platform pivoted at its center, and running on rollers or pulleys on its outside edge and flush with the ground. The car may be driven onto this platform and so turned completely around or in any direction in which it is convenient to drive it off.

Turpentine—An oily resinous substance secreted by the bark of wood of a number of coniferous trees. It consists chiefly of an essential hydrocarbon oil and resin, and is used extensively in mixing paints and varnishes.

Twin-cylinder—The term twin-cylinder originated first with the engines of motorcycles, and refers to two cylinders in the same engine. The expression as regards motor cars is now generally used to denote those engines which have two cylinders placed at an angle to each other, instead of being placed one before the other.

Twist Drill—A cylindrical drill, the body of which has a deep spiral groove as if twisted from a flat bar. The point is sharpened to an obtuse angle.

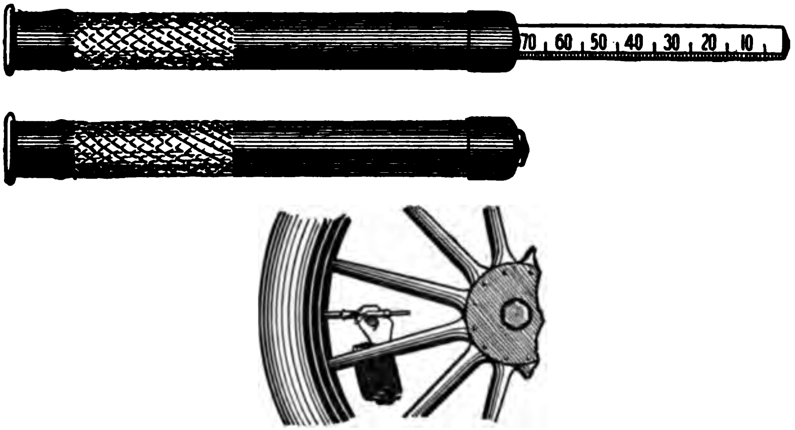
Twist Gear—See under Gear; Skew-gear.

Twitchell Air Gauge—A device for measuring the pressure of the air in a pneumatic tire. This gauge was invented by C. R. Twitchell of Los Angeles, California, and perfected and marketed by the W. D. Newerf Rubber Co. of the same city. It is designed to fill the demand for a cheap, simple device which should be perfectly accurate and always available.

The illustration shows the Twitchell gauge closed, extended, and applied to an automobile tire. It is three-and-a-half inches long, can be carried in the vest pocket, and is always ready for use. It can be applied in two seconds, and the registration is said to be instantaneous and guaranteed to be correct.

Improper inflation is responsible for the great majority of tire troubles. Outwardly, there is very little difference between tires inflated, one to 30 pounds, another to 50 pounds, and another to 90 pounds, which is the proper pressure for the size of the tires.

A tire insufficiently inflated and passing over even slight obstacles is bent or depressed at an angle which quickly causes a rupture in its fabric; whereas the properly inflated tire is depressed scarcely at all, presenting the strongest possible resisting surface.



Twitchell Air Gauge for Tires.

The uninformed or the careless automobile user blames the tire, when the fault is insufficient air pressure and nothing else. He may try all kinds, but he finds the results the same.

A good way properly to inflate a tire is to use a tire pressure gauge to measure what pressure is actually in the tire.

It has not, in the past, always been convenient for the automobile user to make use of a tire pressure gauge. The earlier gauges were bulky, inconvenient and costly. They were not available for use when needed, especially when on the road. Nor were they all to be depended upon as to accuracy.

Ordinarily the automobile user "guesses" at his tire pressure, and almost invariably the pressure is too small. His tires, time, patience and pocketbook suffer accordingly.

Two-Cycle Motor—A motor in which the cycle of operations is performed in two movements of the piston—one up and one down—in contradistinction to the four-cycle motor. See "The Two-stroke Engine" under Internal Combustion Engine.

Two-throw Crankshaft—A crankshaft adapted for producing alternating throws or thrusts in two directions.

Two-to-one Gear—The gearing of two shafts together by means of toothed wheels so that one revolves at twice the speed of the other is known as a two-to-one gear. It is used on practically all motor vehicle engines for driving the camshafts and the shafts which operate the ignition, it being necessary for the operation of the engine that these should be rotated at half the speed of the crankshaft.

Two-to-one Shaft—See Two-to-one Gear, above; also see Contact Maker.

Two-way Cock—A cock by which a fluid may be distributed to each of two branches or to either of them separately, or be entirely shut off.

Two-way Pump—Many lubricating pumps are made to be operated by hand with a cock at the bottom and a simple plunger in the cylinder. The cock is made so that it can open in one direction to the oil tank, and in the other direction to the part to be lubricated. It is turned so as to put the pump cylinder into communication with the oil tank and the plunger pulled up; the cock is then turned so as to put the cylinder in connection with the part to be oiled, and the plunger is depressed, thus driving the oil down. Such a pump forms a convenient means of lubricating, and also of measuring the amount of lubrication given at any time. It is in use on many cars, and in some cases it is so arranged that it can deliver oil to several different parts of the mechanism.

Two-way Switch—See under Switch.

Types of Body—See under Carriage Work.

Typical Construction—Any construction which is standard, or practically so, conforming closely to a type in general or frequent use. Characteristic or illustrative construction, as of any part of a motor car made according to a type adopted by many manufacturers.

Typical Modern System of Lubrication—See under Lubrication.

U

U—Designating similarity or relation to the letter U, as a U-tube; a U-shaped pipe or coupling, etc.

Unattended Cars—Never leave a car unattended with the engine running. Put the hand brake on whenever the car is left for a short time, and always remember to switch off the current. If the stop is to be of any length, turn off the gasolene in case the carbureter needle valve is not in order. Always turn off the lubricating oil.

Under-apron—A protection or shield for the under side of a motor-car mechanism; a dust apron or dust pan. See Under-shield.

Under-apron, Engine—A shield for the under side of a motor, now usually of aluminum or other sheet metal.

Under-frame—The under-frame or sub-frame is that part of the frame of a vehicle which lies below the chassis frame proper, and which is so placed in order to support the engine, and in some cases the engine and gear-box. It allows of the better arrangement of the parts and assists in strengthening the frame and preventing lateral twists, which might put the shafts out of alignment.

Under-shield—An under-shield is now considered necessary in most motor vehicles, as it gives a straight run for the air underneath and prevents dust raising to a large extent. In the case of cars using the flywheel as a fan, it becomes absolutely necessary, otherwise the air will not be drawn through the radiator to the fullest extent. The under-shield is usually made of steel plate or other sheet metal and it is preferably fastened up with wing nuts so that it can be moved bodily.

Underslung Batteries—Batteries suspended from the main frame of an electric vehicle by means of a sub-frame.

Unequal Compression—See under Pounding and Knocking.

Union—A joint in a pipe is often made by a coupling called a union. It is so constructed as to be readily disconnected without turning or moving the pipes joined. The joint is generally made by two adjacent parts, in the form of a male and a female cone, ground to fit together in the same way as valves are ground on their seats. Sometimes a leather or rubber washer takes the place of the ground-in coned surface. Rubber, however, is not suitable for joints in the pipes of the circulation system, or the gasolene or lubricating pipes. See Joints.

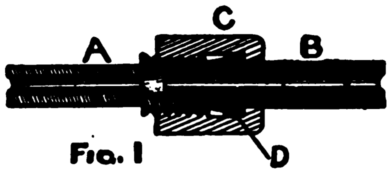


Fig. 1

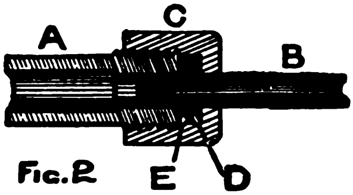


Fig. 2

FIG. 1.
A, Female coned part.
B, Male coned part.
C, Union or spigot nut.
D, Shoulder on B by means of which nut C draws the coned surfaces into contact.

FIG. 2.
A, Female part.
B, Male part.
C, Union or spigot nut.
D, Shoulder on B by means of which nut C draws the surfaces together.
E, Packing washer which forms the joint.

An example of the coned type of joint is shown in Fig. 1, and of the other type in Fig. 2. The index below explains the method of construction and application.

Unipolar Induction—The induction that occurs when a conductor is so moved through a magnetic field as to continuously cut its lines of force.

Units—In mathematics and physics a unit is any known de-terminate quantity by the constant repetition of which any other quantity of the same kind is measured. It may be a length, a surface, a solid, a weight or a time.

Units are divided into two classes, "fundamental" units and "derived" units. Volume, velocity, force and all other physical quantities are derivatives of and can be expressed in the terms of the three fundamental quantities—L, length; M, mass, and T, time. From these three quantities are derived all other physical quantities giving the name "derived units" to those geometric, mechanical, magnetic, and electromagnetic units derived from fundamental units.

Every physical quantity, as angular velocity, acceleration, magnetic induction, etc., may be expressed in terms of one, two, or three of the three fundamental units, L, M, T. The magnitudes of the fundamental units are arbitrary, and in the system in general use the centimeter is taken as a unit of length, the gram as a unit of mass, and the second as a unit of time. This system is known as the absolute or the Centimeter-Gram-Second system, commonly abbreviated C. G. S. system. The Foot-Pound-Second system is also used to some extent, the foot, pound and second being the units of length, mass and time, respectively.

Magnetic Units.—(a) Units based on the force exerted between two magnet-poles; (b) units used in dealing with magnets and magnetic phenomena; (c) the magnetic system of the C. G. S.; electromagnetic units, employed in measuring the force of electric currents.

Physical Unit.—An arbitrary value, measure, or magnitude adopted as a standard in physical measurements, as the meter, dyne, erg, etc.

Thermal Unit.—A unit used in the measurement of quantities of heat, the small calorie usually being considered standard.

Unit of Force.—The poundal or the dyne.

Unit of Heat.—The thermal unit.

Unit of Illumination.—The lux.

Unit of Measure.—Of any quantity, a quantity of the same kind, with which the quantity is compared.

Unit of Output.—(a) The kilowatt; (b) the unit of electric power furnished by the current of a dynamo-electric machine.

Unit of Power—Any unit which measures the rate at which energy is expended.

Unit of Work.—The amount of work done by unit force operating through unit distance, commonly taken as (a) the foot-pound, (b) a dyne-centimeter or the amount of work when a force of one dyne acts through a distance of one centimeter; (c) the erg.

Universal Coupling—See Joints.

Universal Joint—See Joints.

Univeral Joints, Protecting—See Care and Maintenance; Care of a Car on Tour.

Upholstery—A general term for all such fittings or decorations of a car as are made with textile fabrics, leather and the like.

Upkeep—To arrive at any approximation of the cost of running a motor car, many things have to be taken into consideration, and perhaps the most important is the make of car purchased. With a shoddy car the expense is well-nigh endless, and the keeping of accounts in connection with it becomes a distressing and unpleasant task. The personal equation and mere luck govern the matter also, so that it is impossible to lay down generally what a car will cost to run, until the experiment has actually been tried. See Cost of Motoring.

Every motorist should endeavor to keep a record of his expenditure, as it will furnish him with much useful information, and the study of the figures should be of material assistance when he is about to purchase a new car. If the tire bill, for instance, were very heavy, it would indicate probably that he did not use a good type, that his driving was careless, or that the tires were unsuited for the car and the work. The various items of repair would have their lessons also. Especially is the keeping of an account essential where a chauffeur is employed, as it will be a useful check on him.

In a rough daybook, or log book, the money paid for gasolene, lubricating oils, repairs, renewals, etc., should be entered promptly, and a monthly or yearly abstract made. At the end of each half-year, or year, a kind of balance should be struck. Where several cars are kept, the accounts for each car should be kept separate, and, by putting the costs in parallel columns much useful data may be obtained.

Upsetting—The operation of shortening and thickening by hammering, as a piece of metal set up endwise; used also of the shortening and resetting of the tire of an ordinary wheel.

Uptake—The upcast pipe leading to the chimney from the smoke-box of a steam boiler.

Use and Repair of Accessories—See under Accessories.

U-section—Applied to objects whose cross-section resembles the letter U.

Useful Efficiency of a Motor—See under Efficiency.

Useful Information—Under this head there will be found below a number of tips of valuable character that may be studied with advantage by every owner and driver of motor cars. They supplement information given elsewhere throughout the Cyclopedia and can be read as a whole with decided profit to the reader.

Testing Spark Coils.

Spark coils of the vibrator type should not draw more than ½ to ¾ ampère and the vibrator adjustment should be such as to preclude any greater consumption of current. In exceptional cases the consumption required might be 1 ampère. A low-reading ammeter—calibrated to 3 ampères in decimal fractions—should be connected with the coil and battery; one pole to the primary binding post on the coil and the other to the battery wire. All the current will then pass through the ammeter. Run the motor; the needle of the ammeter will rise and drop with each contact. Ammeters for this use are of the "dead beat" kind and the needle will remain practically stationary. The adjusting screw of the coil should then be screwed one way or the other until the ammeter shows from ½ to ¾ ampère. Whatever the ammeter shows, the adjustment must be such as to permit the motor to run perfectly, even if a greater consumption is required. By moving the adjusting screw in and out the effect will be immediately noticed on the ammeter.

Slack in Spark or Throttle Connections.

Slack in the connections between the hand levers on the steering column and the co-timer or throttle in the carbureter is annoying and is often responsible for much trouble that cannot readily be discovered. In the case of the throttle connections, a coil spring can be attached to the throttle lever at the carbureter and the other end attached to some part of the motor, giving as much tension as is necessary to tend to keep the throttle closed. This will be found effective in preventing the motor from jumping, because of the throttle jarring open to the extent of the slack in the connections. If a spring is used to take up the slack in the spark lever connections, it should be so attached as to tend to retard the spark, as otherwise the motor would not run as slow as it might be desired and knocking might result if the motor speed were permitted to fall greatly.

Graphite on Rims.

Where a tire has been permitted to remain on the rim for a long time, it becomes difficult to remove because dirt and rust have crept in and made it stick. A tire should not be permitted to remain on the rim indefinitely and with no attention. In the first place it is hard to remove when necessity requires its removal and then it is harmful to the fabric. To prevent rusting of the rim and difficult removal, clean the rim with emery cloth and apply a solution of graphite mixed with oil or graphite mixed to a stiff paste with shellac. This should be permitted to stand for a little while before the casing is returned to its place.

Graphite for Threads.

Graphite applied to pipe or other threads will tend to permit the parts to be brought closer together and prevent leaking; at the same time it will permit their separation without difficulty.

High Spark; Low Throttle.

Most authorities advise running a car with the throttle as nearly closed as the motor will stand and the spark as far advanced as possible so long as it does not cause the motor to knock. This will prevent heating and will make economical fuel consumption. The tendency of city drivers is to run their motors this way. The result, however, will be a strong tendency to foul the plugs and valves, inasmuch as any excess of oil will not be burned as it would be in the case of a hotter flame inside the cylinder. Where a car is used in the country and an opportunity is given to open the throttle, the valves and plugs will be kept in much better condition.

Cleaning Gas Tubes.

Copper tubes used to connect gas lamps with generators or tanks will clog and water will accumulate therein, causing annoyance and preventing a free flow of gas. If air forced through the tubes by a pump will not remove the sediment, then let fill with water and permit it to stand a few hours. After this the pump can be attached to free the pipe of the water. Not infrequently the sediment becomes so hard that it is necessary to run a small and flexible wire through the tube to break up the accumulation.

Aluminum Solder.

Aluminum solder can be made of ten parts of tin, ten parts of cadmium, ten parts of zinc and one part of lead. A thorough cleaning of the parts and immersion for an hour or more in a solution of hyposulphate of soda is necessary to insure good work.

Cracked Crank Case.

A paste of workable consistency made from a mixture of litharge and glycerine is a most effective agent in making a number of repairs. It can be used to fill cracks in crank or gear cases, leaky radiators where the leak is discoverable and on the outside, cracked outer wall of a cylinder, or small holes in any of the above. Naturally it will not withstand great pressure, but it will prevent oil or water from leaking. It is also effective in use on threads to assure a tight joint, such as valve caps, valve rings nuts, plugs, water connections and gas connections. When applied to a crack, the latter should be thoroughly cleaned beforehand and the mixture should be permitted to stand overnight to set. It should be tamped in where this is possible. Where used on the threads of nuts or bolts the nut or bolt should be set down hard and then permitted to stand overnight to let the litharge set.

Loose Nuts or Bolts.

Most of the modern cars are thoroughly built, with all essential nuts cotter-pinned or with lock washers used with them. Old cars are not so favored. The purchaser of a car, whether it is old or new, will find that a little time spent in going over every nut and bolt will save many a dollar in repair bills; and if this operation is performed once a month much trouble will be averted. It will even pay for the owner to either put lock washers under each nut or to cotter-pin each nut. This work can be done gradually and with little expense. Cotter-pinning is better, but lock washers are excellent.

On an old car, where a nut or bolt has become worn so badly as not to remain tight, and where it is impossible to replace with any certainty of its staying in place, a mild solution of sal ammoniac and water applied will form a rust that will prevent the nut or bolt from ever moving after once being set up and permitted to stand a few hours. The only trouble with this plan is that it is practically impossible to ever remove the nut or bolt without cutting it out.

Repairing Gasolene Pipe.

The gasolene line from the tank to the carbureter is usually made from a small copper tube, such as is used in the gas lamp connection. It is a good plan to carry an extra piece of this pipe, but of a size that will permit it to be slipped over the pipe in the car, so that in case of a break in the line a quick repair can be made. A small rubber hose can will also serve the same purpose, but of course the gasolene will in a very short time disintegrate the rubber and render it useless. It will in time, too, carry particles of the dissolved rubber into the carbureter and close the spray nozzle.

Steering Gear.

Nothing pertaining to a motor car is more vital to the safety of the occupants than a good and well-adjusted steering gear—and it needs constant attention in order that the driver may be absolutely certain that it is in good condition and not apt under ordinary circumstances to give way on the road and cause a catastrophe. Extreme play in the steering wheel should not be permitted, else the operator is continually at a serious disadvantage in driving and in constant danger of a mishap. Most steering gears of the present time are so made that the slack can easily be taken out—and it should be taken out if possible to do so. There are too many different kinds to go into the subject in each particular case, but a little study will show how the tightening process can be performed. All parts of the steering gear should be kept thoroughly cleaned and frequently oiled. This is important, for a stiff steering gear may easily be responsible for a bad accident, particularly when driving at high speed or on a bad road.

Fire.

It is essential that precautions against fire be taken before the fire occurs. Keep a fire-extinguishing tube—or, better still, several of them—not only in the garage but in the car.

Never use water to extinguish burning gasolene; this only spreads the fire.

If a fire-extinguishing tube is not at hand, use sand, dirt, flour or almost anything of the sort.

Ammonia will also serve as a fire-extinguisher in case of burning gasolene.

Pouring Oil.

Oil or any other liquid may be poured from a can without spilling or slopping if the spout—where it is at one side—is placed upward and not downward, as is the custom. By this means the air is permitted to enter and give vent.

Gasolene to Evaporate.

After cleaning a motor, transmission, or other part of a car with gasolene, care must be taken to see that all the fluid has been thoroughly evaporated before the motor is started. Even when the gasolene appears to be gone there is a danger that a strong gas remains and the spark at the timer or flame from an open exhaust would be apt to start a conflagration.

Chains, Care of.

Because of high speed, dust and mud, driving chains on motor cars suffer; and they are too often neglected. A clean chain will transmit much more power than one that is clogged with dried grease and covered with dust or mud. Squirting oil on the outside of a muddy chain is apt to carry the grit into the bearing parts of the links and cause excessive wear at these points as well as at the bearing points on the sprockets. Once every two weeks, if the car is much used, and always after a hard drive through mud or dust, a chain should be removed, placed in a pan of kerosene and permitted to stand several hours. Then it should be rinsed in gasolene to remove the kerosene and loose softened grease. After this it should be placed in boiling tallow and permitted to remain there until it has become heated to the temperature of the tallow. It can then be removed and hung up to permit any surplus of tallow to drip off. The tallow will enter the crevices of the links and will prove a splendid lubricant. Any surplus tallow on the outside of the chain should be wiped off. A little graphite added to the tallow will improve the job materially.

Crank Case Leak.

Where a crank case is divided into halves, oil is pretty apt to find its way out, notwithstanding the presence of gaskets, even when put on with varnish or shellac, as the oil will soon dissolve the shellac or varnish. The leak can be successfully stopped by removing the upper half of the case and cutting a groove in the face of either side—or both sides;—and laying therein a piece of cotton cord or, still better, a strip of felt. When the top of the case is replaced and bolted in place it will press the cord into a solid gasket. Care must be taken, however, that the faces of the two halves of the case are not held apart by the cord, as otherwise the crankshaft might be forced out of line.

Cleaning Gas Reflectors.

Never use polish on the mirror reflectors of a gas lamp or searchlight, as this will soon scratch the surface. Clean water on a clean cloth will serve well and prove generally sufficient to brighten the mirror. If it has become somewhat dull, however, the luster can be restored by cleaning with a mixture of water and alcohol.

Gasolene.

Gasolene is still much misunderstood, although to the user of the fuel the misunderstanding cuts no figure, inasmuch as he will and does take what is offered him and pays for it. Everybody knows it is a petroleum product. Years ago, before gasolene stoves, gasolene engines and gasolene lighting plants were much thought of, gasolene was practically thrown away, as it was a by-product and kerosene, benzine and one or two others were all the light distillates that were marketable. As these gasolene-using devices came into more general use the demand increased. Now it is a product of its own, as it were. The specific gravity of gasolene varies, running from .68 to .72. Petroleum ether is classed as 85 to 80 degrees Baumé, gasolene 80 to 78, naphtha 78 to 60. Usually gasolene is sold as 68, 72 or 76 gasolene. All that is known is that the 76 is better than the 68; some is near kerosene, whose specific gravity is about .75. The composition of gasolene is about: $C84$, $H16$, and the boiling point is from 50 to 150 degrees Centigrade. Kerosene has a composition of $C85$, $H15$, and the boiling point is from 150 to 300 degrees Centigrade. The calorific value of kerosene and gasolene, average, is the same; that is 19,000 B. T. U. (British thermal units.)

Lubricating Oils.

The matter of lubrication is fully discussed in another section of this work and little further need be said here on this subject. The motorist will find from experience that it will pay to buy good grades of oil, even if they cost a little more. He will also learn that it is dangerous and costly to be stingy with oil only to pay heavy repair bills. He will further learn that too much oil will cause considerable trouble in the way of carbonizing, fouling, etc., and that it is an unnecessary waste. One of the important things to inquire into in purchasing a car is the lubricating device. The car of this age should have a positive feed, one that supplies neither too much nor too little. No matter what system is used on a car, it is a wise precaution to have a hand pump and auxiliary tank, so that should the mechanical lubricator fail or should the motor be subjected to extraordinarily hard service the hand pump can be used to force a little oil into the crank case. Let it again be urged that the purchaser, above all things, look into the oiling system when buying a car and if he does not know what is necessary let him take advice from a friend who does. Further, never use oil in the cylinders or crank case that is not made for gas engines.

Grade Percentage.

Degrees and percentage of grade are frequently mixed. A grade of 45 degrees is a grade of 100 per cent. The percentage of grade is the number of feet of rise to each 100 feet horizontal; that is, 100 feet rise to 100 feet horizontal, or 45 degrees, is 100 per cent grade; 50 feet rise in 100 feet horizontal is 50 per cent, or 26 degrees 34 minutes, etc.

Determining Gear Ratios.

The gear ratio of any car may be determined in a simple manner. Remove the plugs from the motor, to relieve the compression and permit the motor to be turned over easily. Engage the high gear, for instance, and then let in the clutch. Do not put on the switch, however. Now mark the tire of one of the rear wheels at the point of contact with the floor. Note where the starting crank is, then turn the motor over by hand, slowly, until the wheel has made a complete revolution. While turning the motor, note carefully the number of times the crankshaft has revolved. This may be two, three, three and a half, or four times; or it may be some whole number and any fraction, like three and seven-sixteenths. This will be the gear ratio of the gear in mesh. To ascertain how far a wheel travels in one revolution, multiply the extreme diameter by 3.1416; this will give the distance traveled in one revolution in inches. Divide by 12 to reduce to feet.

Uses for Air Hose—See Hose, Air.

Using the Brakes—See under Driving

V

V—The abbreviation of velocity, volume, etc.; the chemical symbol for Vanadium.

V—Anything having the shape of the letter V, as a support, wedge, etc.

Vacuum—Space devoid of all matter. Theoretically a vacuum is only obtained when a gas is completely exhausted from a vessel. In practice, any chamber which contains a gas whose pressure is less than atmospheric pressure is said to be in partial vacuum. It is this state which occurs inside a cylinder when its volume is increased by the fall of the piston which causes the gases to flow in, impelled by the superior pressure of the atmosphere without.

Vacuum Gauge—An instrument for indicating difference between the external atmospheric pressure and the pressure inside a partially exhausted vessel.

Vacuum Pump—An air-pump. See Pumps.

Valve—A movable device or appliance used for regulating or controlling the admission or escape of a liquid, gas or steam through a pipe, port or passage. See Valves, below.

A cock or tap is a small plug valve operated by hand. Similar devices moved by screws or levers, or operated by power through some machinery, all self-acting appliances, and all large or complicated gates, stoppers or cocks are called valves.

Valve Box—A box placed over or containing a valve or valves.

Valve Bucket—A pump bucket or sucker.

Valve-cage—A perforated box placed over a valve to hold it in place and permit the passage of a fluid; the steam-chest in a steam engine.

Valve-cam—One of the cams that actuate the inlet and exhaust valves of a motor.

Valve Chamber—An opening or side passage or chamber in the head of a cylinder, in which the valve operates and into which the gases have to pass to or from the valves.

Valve Cock—A form of cock or faucet which is closed by the dropping of a valve on its seat.

Valve, Cut-out—See Exhaust Cut-out, under Engines.

Valve, Exhaust—See under Internal Combustion Engine; also Valves, below.

Valve Face—The face of the valve is that part which comes in contact with the seat upon which it rests. By an examination of the face, it may be determined whether the valve is seating properly and not leaking. If the face of the valve when the latter is rotated on its seat shows a clear white line completely round the valve it is seating properly. See "Valves" in Repairs and Adjustments.

Valve Gear—The mechanism used in operating a valve.

Valve Gear, Overhauling—See Overhauling.

Valve, Gridiron—A form of slide valve in which parts arranged somewhat like a gridiron have an equal number of parts similarly arranged in the seat.

Valve, Induction—Same as Inlet Valve.

Valve Joint—In cases where automatic inlet valves are used, it becomes necessary to arrange them on a separate piece which is held into position in a housing in the cylinder by means of a clamp or dog. In such cases a joint is made, generally by means of a copper and asbestos washer. This is also the case where inlet valves are mechanically operated, but inverted on the top of the cylinder. It is necessary that this joint should be kept tight to prevent loss of compression.

Valve Key in Cylinder—See under Engines.

Valve Lift—A term used to denote the height to which the valve attains from its seat when it is lifted to its full extent by the cam. It is unnecessary to lift the valve to any greater height than that which would cause the annular opening between it and its seat to equal in area the area of the valve mouth at its smaller diameter, less the area of the valve stem.

Valve-lifter—A push-rod or other device for lifting a valve from its seat.

Valve, Needle—See Needle Valve, under Valves, below.

Valve Not Seating—See under Missing Explosions.

Valve Nuts Not Tight—See under Loss of Power.

Valve, Poppet—See under Poppet.

Valve Rod—Used in connection with steam car practice and indicates the rod, operated by an eccentric, which moves the slide valve; also applied to a valve stem.

Valves—Valves are of many types, and are classified either from some peculiarity of shape, or from the functions they perform. The following are some of the valves used in motor-car mechanism and their chief uses:

Admission Valve.—The inlet valve. In modern practice the valve admitting the gas to the cylinder is of the same design as the exhaust valve, as illustrated further on. (See Inlet Valve.) The valve which allows the exhaust gases to pass to the gasolene tank in pressure fed systems is also a form of admission valve. (See Suction Valve.)

Air Valve.—A valve for admitting air to a carbureter or to a steam boiler, etc.

Annular Valve.—In some methods of construction one valve of the mushroom type is placed inside another. In this case the outside valve is an annular valve.

Atmospheric Valve.—See Suction Valve.

Back Pressure Valve.—The back pressure valve is of the nature of a check valve, and is used in feed pumps in steam motor cars to prevent the steam forcing the water back in the main water pipe.

Ball Valve.—A ball valve is one in which a ball sits down on a seating. The air or liquid in passing through the valve lifts the ball and flows around it, but on pressure being applied to return the liquid or gas, the ball drops down on its seat and prevents its passage. Ball valves, such as are used on domestic cisterns, where a hollow ball rises with the water and closes the cock through the medium of a lever, are not used in motor-car work.

Blow-off Valve.—A blow-off valve is used in steam engines and is of the nature of a safety valve, allowing the pressure to be released when it reaches a certain predetermined amount. It is also part of a pressure feed system, and allows the release of the air pressure on the gasolene when it rises too high. The filling cap of the radiator is sometimes fitted with a release valve, which forms a blow-off valve, and allows of the escape of steam should the water boil.

Butterfly Valve.—See Throttle Valve.

Check Valve.—Any valve which allows a liquid to flow in one direction but not in the other may be rightly termed a check valve.

Clack Valve.—A clack valve is a non-return valve often used in pumps. It is a valve which sits down on a flat seat generally faced with leather, and is hinged at one side. It is very seldom used in motor-car work.

Conical Valve.—The ordinary valve used in motor car practice is a conical valve. (See Exhaust Valve.)

Delivery Valve.—A valve which allows a liquid or gas to flow through from the pump, such as in oil, air, or water pumps—the latter in the case of a steam car.

Exhaust Valve.—A valve which allows the exhaust gases to flow out from the cylinder on the exhaust stroke. (See Internal Combustion Engine.)

This type is the most important of all in internal combustion engine construction. The exhaust valve is set to open once for every two revolutions of the flywheel, so as to allow for the escape of the exploded charge.

The illustration shows how it is operated. A is the crank or engine shaft, on to which the pinion B is fixed, which meshes with the second pinion C, exactly double its size. C will therefore revolve once for every two revolutions of B. The shaft D, on which C is fixed, is consequently called the two-to-one or half-time shaft, and also operates the timing of the electric spark, as described under Internal Combustion

Engine. E is a cam which forms portion of the pinion C. F is the exhaust valve with its stem resting on J. J is the plunger working in a slide, which is actuated by the cam E. In the illustration it will be seen that the projecting part of the cam E is upward, and is lifting the plunger J, which in turn acts on the stem F, and lifts the exhaust valve off its seating, allowing the burnt charge to escape. When the cam E moves a little further forward, the projecting part drops from under J, whereupon the spring G returns the valve to its seating, and the combustion chamber of the engine becomes gas-tight once more.

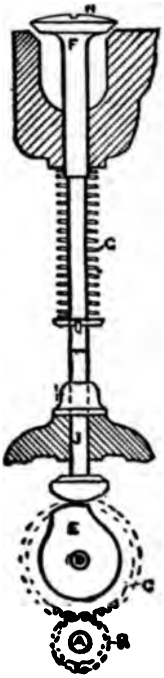


FIG. 1.—EXHAUST VALVE.

Practically the same construction is now almost universally used for inlet valves, except in some small motorcycle engines.

The illustrations (Figs. 2 and 3) show the two patterns of valve in use. That shown in Fig. 2 is by far the most common.

The exhaust valves of internal combustion engines are sometimes made with the head of a different metal to the stem, in order that the valve head may withstand the enormous heat of the exhaust gases better.

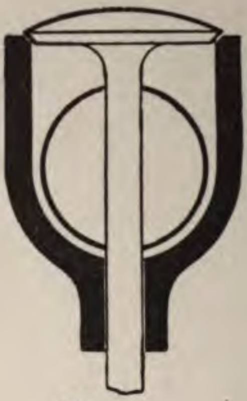


FIG. 2.

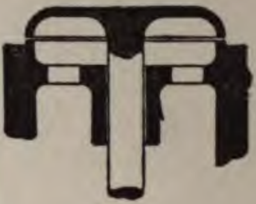


FIG. 3.

The head of the valve generally has a slot cut in it to receive a turnscrew for grinding-in purposes.

Feed Valve.—This term is generally used to refer to valves which allow the fuel to pass, such as the valve leading from the fuel pump in a steam car to feed the burner, or similarly to feed the boiler with water.

Flap Valve.—As the name implies, the flap valve comprises a "flap" of metal (sometimes leather-faced) hinged at one edge and bedding on a flat seat. This pattern of valve only permits a flow of water in one direction. Also called Leaf Valve.

Indiarubber Valve.—Indiarubber valves are not frequently met with in motor car practice, though they are found in motorcycle tires.

Inlet Valve.—Generally referring to the inlet valve to the cylinder. Most internal combustion engines are now built with their inlet valves operated mechanically in the same manner as their exhaust valves, and where this method is adopted the inlet and exhaust valve are usually made interchangeable. This type is illustrated under "Exhaust Valve."

The size of the valves, of course, depends on both the size of the engine and the speed at which it is required to run. Many of the older types of engine had both inlet and exhaust valves too small, so that much power was lost both by throttling the inflow of gas, and by the back pressure caused in the exhaust. The higher the speed of the engine, however, the larger the valve should be, and the less the lift.

Mechanically Operated Valve.—The term used to differentiate between those valves which are opened by the mechanism of the engine, and those which are opened automatically by suction. In early engines, and also in a great many present motorcycle engines, the inlet valve opened automatically by the suction of the piston. It is now the general practice to open all valves at a stated time by means of cams. (See Internal Combustion Engine.)

Mushroom Valve.—The circular valves used in motor car practice are examples of the mushroom valve, the name being taken from the shape of the valve, which resembles somewhat that of a mushroom. Strictly speaking, a mushroom valve is one which has a head similar to that shown in the illustration, Fig. 3, under "Exhaust Valve."

Needle Valve.—A valve which is formed of a needle or slender spindle, its end being coned and falling or being screwed down on to a coned seating at the end of a small circular orifice. Needle valves are used in carbureters to automatically close the gasolene supply when the gasolene level in the float chamber is at the correct height. They are sometimes used to shut off gasolene, in which case they are screwed through the tank, and their conical ends sit down in a conical seating in the delivery pipe. (See Carbureter.)

Piston Valve.—A valve which is arranged in the form of a cylinder having a piston sliding within it. The sliding of the piston covers or partially covers, or opens or partially opens, an orifice in the side of the cylinder. Piston valves are used in connection with automatic carbureters to supply the extra air in various quantities according to the speed of the engine, the piston being operated through the medium of the suction above it or on a diaphragm to which it is attached. Piston valves are also used as throttles.

Pressure Valve.—A valve by means of which the pressure of the exhaust gas is used to feed gasolene to the carbureter, or oil to the sight feed lubricators. The pressure valve really contains two mushroom-headed valves, the one to retain the pressure, the other to act as a safety valve when the pressure rises above a certain point. The exhaust gas enters at a point below the head of the lower valve and raises it against the pressure of a spring, which tends to keep it closed and prevents the gas returning. The gas then enters a small chamber, from which a pipe leads to the reservoir. The top of this chamber is formed by the head of the second valve, which is kept closed by an adjustable spring. Should the pressure rise too high, this valve opens and allows sufficient gas to escape to reduce the pressure to the normal amount.

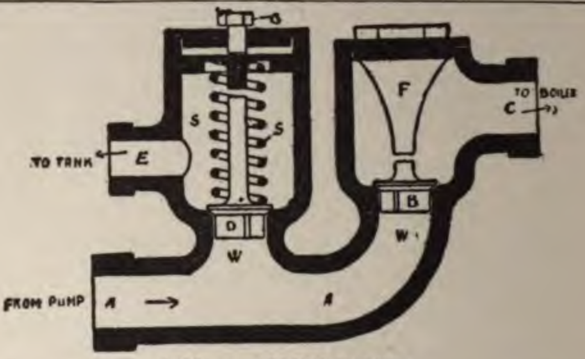


FIG. 4.—RELIEF VALVE.

Relief Valve.—A relief valve is fitted to steam boilers and to oil and gasolene tanks under pressure in order to release the pressure when it rises above a predetermined point.

Our illustration shows one form of relief valve. The water enters from the pump at A and passes through the check valve B out to the boiler at C, the stop F preventing valve B from rising too high. This prevents the boiler pressure from acting against the pump. Should the pressure in the boiler rise too high for the pump to lift against, the relief or safety valve D rises against the pressure of the spring S regulated by the screw G, and the water flows back to the tank by the outlet or by-pass E. A steam safety valve is practically the same appliance without the addition of the check valve V or the boiler outlet W.

Rotary Valve.—This form of valve is used in connection with the steam distributers on a few steam cars. The valve is caused to revolve from the engine shaft, and acts by uncovering or cutting off passages by which the steam enters or leaves the engine. These valves are generally in the shape either of a long cone or a flat disk, and are pressed to their seats by the steam, so that in addition to the joint being kept tight, the wear is automatically taken up. In a few internal combustion engines where the cylinders revolve around the crankshaft, rotary valves become a necessity, but otherwise are seldom used in automobile work.

Safety Valve.—See Blow-off Valve.

Slide or Sliding Valve.—Sliding valves are not used in internal combustion engine practice to any extent, but they are often used in steam engine practice. They are a form of valve in which sliding plates cover or uncover ports which open onto a surface on which the plates slide as in the steam chest of a steam engine, the valve in this case being known as a slide valve.

Spring Valve.—Any valve which is controlled by a spring.

Suction Valve.—Any valve which opens by reason of a difference of pressure on either side of it is known as a suction valve. The automatically operated inlet valve of an internal combustion engine is a suction valve, and is opened by the difference in atmospheric pressure inside and outside the cylinder, due to the increased volume caused by the falling piston

Throttle Valve.—The valve which throttles the area of the supply pipe from the carbureter to the engine in the case of an internal combustion engine, or from the boiler to the steam engine in the case of a steam engine.

In general practice, throttle valves are confined to two types: the butterfly valve and the plug throttle. With the first, a plate of metal, elliptic in shape, is attached to a spindle passing transversely through the valve. The edges of this plate are so beveled that when in its extreme position it completely closes the pipe. The maximum opening is obtained when the "butterfly" is parallel with the axis of the pipe. Adjustment between these two positions regulates the supply of gas to the engine. The illustration shows a butterfly valve in section. In the longitudinal section, the disk A is seen parallel to the center line of the bore of the valve. The spindle to which the disk is fixed is seen in the view of the end section which also shows the actuating lever B. The dotted lines, at C and D, show the valve closed, and the relative position of the actuating lever. This type of valve is largely used in connection with the governors of steam engines, being placed in the steam supply pipe.

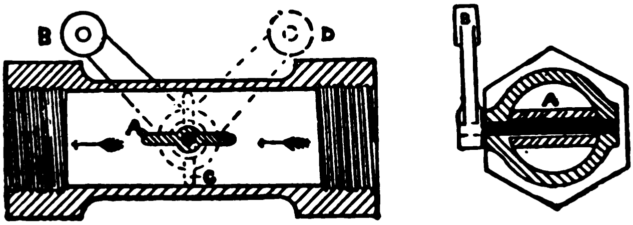


FIG. 5.—BUTTERFLY THROTTLE VALVE.

With the second form the valve casing has a parallel bore in it, into which a cylindrical hollow plug fits and either turns or slides. This plug has apertures in it, and is operated by means of a lever or draw rod from the outside of the casing The amount of opening can thus be regulated to a nicety by turning or moving the plug to various positions. The throttle valve of a steam engine as used on steam cars is generally of the sliding type.

Tire Valve.—A non-return valve for allowing air to be pumped into a pneumatic tire and for preventing its return.

Valves, Distorted or Sticking—See under Engines.

Valve Seat—The conical annular face ground in the cylinder walls into which the valve drops, and with which it makes an air-tight joint.

Valve Setting and Ignition Timing—Comparatively few motorists are at all sure of the methods to adopt when the necessity arises to reset the timing gear of their engine.

Such a knowledge might save considerable expense if at any time it became necessary to fit a new distribution pinion, a new contact cam, or another tappet on a low tension magneto make-and-break. But not only in a pecuniary sense is an understanding to be desired, but on the point of convenience also, for, in the event of a commutator or magneto driving chain breaking or becoming detached on the road, hours might be saved, says Mr. Marcus W. Bourdon in an interesting article on the subject, if the driver or owner was able to correctly replace the old chain or fit a new one; especially so, if the work could be done without hesitation, by reason of a knowledge of the best method to adopt in the process.

Setting the Valves.

We will imagine that the engine we are dealing with has mechanically operated inlet valves, and that these are fitted on the opposite side of the cylinders to the exhaust. We will also imagine that the small timing—by some termed "distribution," by others "two-to-one"—pinion has become loose on the crankshaft, by reason of the cotter securing it having fallen out. Not only so, but the pinion has moved forward on the shaft, and is out of mesh with the two large wheels, one on each side of it, and neither these latter nor the small one have any mark on their "faces" as a guide to refitting.

We thus have a condition in which the whole of the timing of both inlet and exhaust valves is upset. We have not only to refit the cotter in the correct direction according to the corresponding taper in the shaft and pinion, but we have also to mesh the teeth of both large wheels with those of the small one in such a way as to cause the valves to open and close at the proper time.

In dealing with a multi-cylinder engine, it is only requisite for this purpose to consider one of the cylinders, for if the valves of that one are correctly timed, those of the remaining cylinders will necessarily be in order also. For the sake of convenience, we will deal with the front, or No. 1, cylinder.

Now, a mechanical inlet valve should commence to open immediately after the exhaust valve has taken a seating—that is, closed—and both these points should occur when the piston is exactly at the top of its stroke. Therefore, in order to obtain a basis upon which to work in timing the valves, we must first of all turn the engine by means of the starting handle until the piston of the front cylinder is at its highest point. This can be ascertained by either pushing a piece of wire through the compression cock at the top of the cylinder, or if a tap is not fitted, by removing one of the caps covering the valves, from either exhaust or inlet side, when the piston will be seen or its movement felt by means of the wire.

The piston being at the top of its stroke, we must now turn the large pinion which is attached to the inlet camshaft to the left, or contra clockwise, that is, in the reverse direction of rotation to that of the crankshaft, until the front inlet valve commences to lift, or rather only until a slight pressure is exerted by the cam upon the valve tappet base, which pressure can be felt in turning just prior to the actual beginning of the lift. In some engines a loose or intermediate pinion wheel is situated between those on the crank and camshafts, and in such a case the camshaft revolves in the same direction as the crankshaft when the engine is running, and should be so rotated when testing and timing.

The inlet valves are now set. The exhaust camshaft must now be turned in the same direction as the inlet side, until the valve of the front cylinder has just closed, and then all that remains to be done is to slide the small pinion along the crankshaft and into mesh with the teeth of the two large wheels, but at the same time keeping the holes for the taper pin in a line with that through the shaft, and making sure that the large hole in the pinion is at the same side as the larger end of the hole in the crankshaft.

If all the foregoing instructions are correctly carried out, the small pinion will mesh with the larger ones without the necessity for their being moved either one way or the other, and when they are meshed it will be found that the holes for the cotter pin in the shaft and pinion are in line. Before turning the engine, care must be taken to refix the pin tightly by driving it in with the punch and hammer, not using such force with the latter, however, as would be likely to bend the end of the shaft.

If the small pinion is driven by the shaft by means of a feather key as well as a pin, or only by a key, for all practical purposes the same instructions apply.

In some engines the ignition apparatus, whether high or low tension magneto, battery and coil, or otherwise, is driven by a chain directly from the back end of the crankshaft (the two-to-one reduction being obtained by the relative sizes of the chain sprockets), and not from one or other of the camshafts. If this had been the case with the engine the valves of which are supposed to be retimed, the method should have been as follows: When turning the engine at the commencement of the work, the time of firing No. 1 cylinder should have been noticed, by (if no other means are available) running the spark plug and observing when the spark takes place. This will occur, if the ignition lever is placed at about one-third advance, almost at the moment the piston reaches the top of its stroke. Note the spark, stop turning, then carefully turn the engine one complete revolution from the point where the spark took place. This should bring the piston to the top again, or at most vary but a slight degree one way or the other, and after correcting any such variation, it is with the piston at the top of the stroke that the preceding directions regarding the setting of inlet and exhaust valves must be followed throughout. That is to say, the inlet valve must commence to open when the engine crankshaft has completed one revolution after reaching the top of the firing stroke. If a low tension magneto is used, the cams for giving movement with the firing tappets will be fitted on the crankshaft of the inlet side, so that in setting the inlet valves the timing of the tappets will also be accomplished.

Timing the Ignition.

(1.) Low Tension Magneto.—Supposing the magneto has been entirely removed, or, if chain-driven, the chain has become detached either by accident or design, the firing can be timed by one cylinder only, as with valve setting, and the engine must be turned by hand until one of the tappets is about to break contact with its firing plug in the cylinder. This can be judged by the external movements, for, bearing in mind that the tappet is normally out of contact with its firing plug, it will be noticed that in turning the engine contact is made and then rapidly broken; the rods giving this movement may either lift the tappets up and then pull them down, or vice versa, or, again, in some engines a rotary movement of the rods causes the tappets to make and break. Just as contact is about to be broken, cease turning the engine, and leave it at that. Then place the magneto on its bed, and, without bolting it down or allowing the teeth of the driving wheels to mesh, turn the armature by hand by means of the pinion wheel attached to it, in the direction in which it usually rotates, and in doing so it will be noticed that at certain points in each revolution a resistance to rotation occurs, followed by a tendency for the armature to spring forward in the same direction. Steady the hand by resting it on some fixed part, and slowly turn the armature until the resistance is overcome at one of the points, and the tendency to spring forward is felt. Then hold it securely in that position, mesh the pinions, and temporarily bolt down the machine to the frame. If the engine does not then start as readily as usual, unbolt the machine and mesh the pinions at a point one tooth either backward or forward, experimenting as to ease of starting after each alteration. In the case of a chain-driven magneto with the chain detached, turn the armature slowly until the same point is reached, and then, if the chain sprocket cannot be held while another person fits the chain, wedge or secure it in some way with wire or string, but be careful that the armature does not move much in either direction during the fitting of the chain.

(2.) High Tension Magneto.—(a) The Eisemann Magneto. First of all set the ignition timing lever in such a position as will cause the spark to have about one-third of its advance, then turn the engine by hand until the piston of the front cylinder has reached the top of its stroke. This must be ascertained by means of a piece of wire applied through the compression cock, or the hole in the top of the cylinder where the valve cap is fitted. If it is noticed that the exhaust valve has just closed, or the inlet valve is just opening, one more complete revolution must be given to the engine crankshaft, and the position of the piston verified, for it must be exactly at the top. Remove the spark plug from the front cylinder, and rest it, with wire attached, on the top of the engine, or on a convenient spot where it has contact at the screwed end with ground. Now, by means of the chain wheel rotate the armature as sharply as possible half a turn at a time in the direction it usually revolves until a spark is seen at the plug; but immediately this is noticed, cease rotating the armature, and turn it slowly in the reverse direction until the platinum points on the low tension contact breaker are separated. This should first bring the machine to a point where it is in position for firing No. 1 cylinder, and the chain may therefore be refitted on the sprockets, care being taken not to alter the position of the one on the magneto. If the pawls on the high tension distributer are numbered 1, 2, 3, and 4, to correspond with similar numbers on the cylinders, merely turn the armature until pawl No. 1 is in contact with the brass segment, and then move the armature again in one direction or the other until the platinum contacts are separate, as before. However, be sure that the piston is at the top of its stroke, and that the ignition lever is not advanced more than one-third of its movement.

(b) The Bosch Magneto.—The Bosch high tension magneto, as now made, varies considerably as compared with the Eisemann, in that it has no separate induction coil; in fact, unless the windings of the fixed armature can be so called, it has no induction coil at all. When retiming the ignition of an engine fitted with this type of magneto, it must be borne in mind that the machine gives four sparks in each revolution of the rotating sleeve—when fitted to a four-cylinder engine—as against two in the more ordinary type of magneto with a revolving armature. For the purpose of considering the matter of retiming this machine, we will suppose that it is driven by a chain, and that the chain is detached or broken.

When the Magneto is Chain Driven.

At the chain wheel end of the machine will be seen a solitary milled-edge screw, which holds in position the condenser and its casing. Remove this screw, and carefully draw away the condenser, and when this has been done the segments which form the revolving sleeve will be in view. Turn this sleeve by means of the chain wheel until a notch in the surface of one of these segments is seen. (This notch indicates the position of the revolving segment of the high tension distributer, and this latter, being situated at the opposite end of the machine, is so placed that it cannot be seen unless a number of parts are removed; and for this reason the makers provide the notch as a guide.) Now, allow the sleeve to be drawn back by magnetic force, or turn it by hand, until the notch is in line with one of the top high tension terminals, which are set at 90° from each other round the distributer. That is to say, set it in line with the terminal, which, when looking at the machine from the distributer end, is at the left-hand top corner, and note that this terminal is in connection with the high tension wire, which is fitted the second from the left on the quadruple plug. Follow this wire along to the engine, and observe to which cylinder it leads. Then turn the engine by the starting handle until the piston of that cylinder is in a position for firing with a retarded spark, that is, about one inch down on the firing stroke; return to the magneto machine, set the timing lever in its retarded position, and rotate the sleeve very slightly—a movement of a quarter of an inch or so should suffice—by means of the chain wheel until the platinum points of the low tension contact breaker are in the act of separating. Hold the sleeve firmly in this position, and fit the chain on its wheel while they are so situated. Then slide the condenser back into place, and secure it with the milled-edge screw. If the foregoing directions are carefully followed out, the timing will then be in order.

Retiming with a Separate Distributer.

When retiming a high tension magneto the distributer of which is separate from the machine and driven by another shaft whose timing will therefore be unaffected, it is only necessary to see that the low tension contacts are in the act of separating, the piston of any one of the cylinders being at the top of the firing stroke and the ignition advanced about one-third, and then to fit the chain or mesh the pinions at that point.

High Tension Battery and Coil Ignition.

In refitting the driving chain, or meshing the pinion wheels, of a commutator with wipe contact in conjunction with a trembler coil, set the ignition lever advanced about one-third of its movement, and with the piston of No. 1 cylinder at the top of its firing stroke, namely, one complete revolution after the exhaust valve has closed, turn the commutator by hand until the trembler on the coil corresponding to the same cylinder gives forth its "buzz," and then fit the chain, or mesh the wheels in that position.

When the high tension distributer is fitted with only one coil, watch the former while turning the commutator by hand—with the ignition lever and piston arranged as above—and when the revolving "lead," or segment, is opposite No. 1 "collector," or high tension terminal, secure the driving mechanism, either chain or pinion wheels, at that point.

With a make-and-break contact and non-trembling coil, follow the same directions as those in reference to a "wipe," except that instead of turning the commutator until the trembler works, do so until No. 1 blade makes contact with the platinum-tipped screw.

In fitting a new wipe contact disk to the half-time shaft, it must not be taken for granted that the grub screw (or the cotter pin, if one is used to secure the disk) can be fitted into the same hole in the shaft as the old one. To obtain the correct position, or to verify the position, of the old hole, the piston of No. 1 cylinder should be at the top of the firing stroke as usual, and the ignition lever set at one-third advance. Then turn the disk on its shaft—in the direction in which it should rotate when the engine is running, and with the grub screw removed—until the blade or roller is in the center of its contact with the brass segment. With a long pin, or sharp-pointed tool, scratch the shaft through the screw hole, remove the disk and at the point where the scratches appear drill a hole to a depth of about one-eighth of an inch with a drill of the same size as the screw. Then refit the disk, tightening the screw into the hole just drilled.

Various Notes on Retiming.

When meshing the pinion wheels of an exhaust camshaft, the chief aim should be to so arrange that the valve closes at the instant the piston reaches the top of its upward movement after the firing stroke. Do not consider so much the point at which it opens; that at which it closes is of far greater importance, especially in engines fitted with mechanical inlet valves. Explosions in the carbureter, apart from loss of power, are likely to occur if both valves are momentarily open at the same time.

Synchronizing the Ignition Points.

If at any time it should become necessary to fit a complete new tappet, or maybe only the rocker arm, as used in conjunction with a low tension magneto, great care should be taken to adjust the movement of the lifting rod and the external arm on the tappet spindle in such a way as to cause contact with the firing plugs to be broken at the same point of the movement of the pistons in all of the cylinders. Failure to synchronize the movements would result in premature or late firing in one or more cylinders, causing a "knock," or in the latter case loss of power.

After Fitting New Parts.

It may be thought advisable at some time or other to fit a complete set of new tappets. In this case, supposing the period in the movement of the piston when the "break" occurred with the old one has not been noted before removing them, perhaps the best results are obtained, and that without backfires in starting, by so setting the new tappets that contact is broken when the piston is about a quarter of an inch from the top of its movement on the compression stroke. This, however, is with an engine with a fixed time of ignition; where an "advance" movement is provided the operator should retard fully and set the "break" to occur at the top of the firing stroke, not a quarter of an inch or so down this stroke, as with battery ignition with the lever fully retarded.

In the case of a high tension magneto where neither the low tension contacts nor the high tension distributer can conveniently be seen, and it is desired to refit the timing wheels, find approximately by sharp half-turns of the armature the point at which the spark takes place in the cylinder which has its piston at the top of the firing stroke, and then, by a rocking movement of the armature, set the timing, as described in the case of low tension magneto, by the resistance and "pull" to rotation which is felt. This, however, is not a certain method with high tension magneto, but it is near enough to merely necessitate an alteration, if any at all, of but one tooth of the driving pinion or chain sprocket one way or the other—advanced or retarded.

Retiming with a Separate Distributer.

When retiming a high tension magneto, the distributer of which is separate from the machine and driven by another shaft whose timing will therefore be unaffected, it is only necessary to see that the low tension contacts are in the act of separating, the piston of any one of the cylinders being at the top of the firing stroke and the ignition advanced about one-third, and then to fit the chain or mesh the pinions at that point.

Care of Low Tension Magnetos.

Magnetos, wherever placed, should be carefully protected against oil and dust. Water does not affect the current-producing qualities of a magneto, except that it may cause a short circuit in some place or other, and therefore for this reason, and for the still more important one that rust destroys the connections, magnetos should be protected by a water-tight covering. Oil or gasolene deteriorates, softens, and ultimately dissolves the insulating material, besides serving to collect dust.

Care should be taken to lubricate the various magneto bearings. If force feed grease lubricators are not fitted, the oil lubricators should not be overfilled, and should be closed after oiling.

Such is the general attention which should be given to magnetos. The advice given with regard to fixity of terminals, carriage of wires, and plugs in the case of battery ignition, applies equally to magneto installations.

So long as the armature is not removed from its position between the pole pieces of the magnets, the latter will not lose any of their magnetism, but if the magneto is at any time dismounted and the armature removed for any purpose, the magnets should not be left a moment without protection. A piece of soft iron should at once be placed across the poles after the manner of those attached to the little magnets sold as toys for children.

The windings on the armature may not be expected to break, but it is not difficult to test for a fracture of this description.

A short circuit in the wiring from magneto to plug is always easy of discovery, because of the very short length of wire.

A magneto should never be dismounted without marking it and its connection to the gear drive, so that it can be replaced exactly as before. The engine should be stopped with the piston in a known position. Expose the armature and carefully mark its position at the same time.

When a magneto is set to fire one cylinder, it is set for two or four, as the case may be.

Let us presume that a low tension magneto has been dismounted, and it is desired to replace it in its proper firing position:

1. Expose the armature by removing the plate covering it.

2. Turn the engine until one of the ignition tappets is about to break contact.

3. Put the ignition lever as far forward as it will go, when the armature should be as nearly as possible vertical—that is, with the current flowing at its maximum. We say as nearly as possible vertical, because in practice it is found best to give the armature web a slight inclination to the left, or backward in the sense of its rotation.

4. The magneto is properly adjusted if, with the ignition two-thirds retarded, the motor starts without backfiring.

One piece of advice must not be omitted: Never take a magneto to pieces. There is nothing in its interior to adjust, and you may quite upset its economy if you meddle with it.

The owner of a car driven by an engine fitted with low tension magneto ignition should make himself acquainted with the exact distance which should occur between his ignition tappet rods and his ignition tappet levers. In a four-cylinder engine, the same distance should obtain between the tappet rods and levers in the case of each cylinder. This insures synchronous running of the engine, though each igniter mus be adjusted till the cylinders pull equally well.

Valves, Grinding in—See under Repairs and Adjustments also under Overhauling.

Valve Spring—A spring fitted to hold a valve to its seat, a an inlet or an exhaust valve.

Valve Spring Extemporizing a—See under Driving.

Valve Springs, Stiff—See under Loss of Power.

Valve Spring Testing—See Overhauling Hints and Tips under Overhauling.

Valve Spring Weak or Broken—See under Missing Explosions; also under Loss of Power.

Valve Stem—That part of the valve which forms a guid running through the sleeve in the cylinder walls, by mean of which the valve is lifted and at the same time kept in straight line so as to descend fairly on its seat. Also called spindle.

Valve Stem Bent—See under Missing Explosions; als under Loss of Power.

Valve Stem, Lengthening a—See under Engines.

Valve Stems, Oiling—See under Oiling.

Valve Stem Sticking—See under Missing Explosions.

Vanadium—A metal discovered by Sefstrom in 1830, o white color and strong metallic luster. It is not oxidized b either air or water and while extremely brittle it is valuabl as an alloy of steel.

Vanadium Steel—See under Steel.

Vane—A contrivance attached to an axis and having a surface exposed to a current of air or other fluid, so as to be actuated thereby, as the arm of a windmill, a fan, the blade of screw-propeller, etc.

Vapor—The gaseous form which a solid or liquid substance assumes when heated. It is essentially a gas, and as al known gases have been proved to be liquefiable, no physica difference can be said to exist between an ordinary gas, such as oxygen, and a vapor, such as steam.

Vaporization—The turning of a liquid into a gas or vapor. It is the object of the carbureter to vaporize the liquid gasolene.

Vaporizer—An appliance used to vaporize the heavy or volatile fuel in steam car practice by superheating the fuel, so that it may be readily burnt in the burner, the vaporization afterward taking place automatically. The carbureter of an internal combustion engine is practically a vaporizer for lighter fuels.

Variable Expansion—A term used in connection with steam car practice. The expansion of the steam behind the piston can be increased or decreased by means of the variation of the "lap" and "lead" of the slide valve, otherwise known as early and late cut-off. By cutting off the steam supply at an early part of the piston stroke, its expansive properties are made use of instead of its absolute pressure.

Variable Gear—A change speed gear. See Transmission and Variable Gear under Change Speed Gear.

Variable Speeds—See Change Speed Gear.

Varieties of Frame Construction—See under Frame.

Varnish—A solution of resinous matter, forming a clear limpid fluid capable of hardening without losing its transparency; used by painters and coachbuilders for coating over the surface of their work in order to give it a shining transparent and hard surface, capable of resisting in a greater or less degree the influences of air and moisture.

Varnish, Care of Car—See under Care and Maintenance; Saving the Paintwork, etc.

Varnish for Electric Terminals—See under Ignition.

Vaseline—A semi-fluid viscid product of petroleum; also called petroleum jelly. Used as a lubricant and dressing for leather, chains, etc.

Velocimeter—An apparatus for measuring velocity or speed as a speed-gauge or speed-recorder for machinery.

Velocity—Rate of motion; speed; the rate at which a body changes its position in space, measured in distance per unit of time.

Venturi Tube Construction—A form of tubing used in carbureters (first embodied in the Breeze carbureters in 1904). It is intended to get an intimate mixture of air and fuel at low speeds and as far away from a puddle and pockets in piping as possible, as these affect an engine badly, besides causing it to flood occasionally, and stop dead, which is dangerous at all times, especially in the path of a trolley car. The Venturi tube construction is only automatic within a moderate ratio of air velocities, and when made small enough to give, not merely a correctly proportioned mixture, but a good one that will give power without wasting fuel or burning up the engine, needs an auxiliary air valve on higher speeds.

Vertical Motors—The popularity of the vertical motor is largely due to the fact that it is easier to place in such a position in the frame that all the parts can be got at without unduly extending the frame. The top of the combustion chamber and two sides of the motor are fully exposed in the vertical type, while the horizontal type only exposes the end and one side. Makers of the vertical motor claim that the weight of the moving piston in the horizontal motor tends to wear the cylinder oval, while in the vertical engine the wear on the piston is equal on all sides. Neither contention is exactly right. It has been found that with a well-made horizontal engine with the engine running underhand the wear is practically equalized. On the other hand, such firms as the makers of the Mors car have constructed their latest vertical engines with the cylinders set off from the center of the crankshaft so as to reduce the angular thrust on the piston during the power stroke. See Offset Cylinder. As a matter of fact, with well-made engines the wearing oval of the piston is more of a bogey set up by partisans than anything else.

Vibration—When the vibration of any running machine is spoken of, the vibration meant is that of the frame of the machine; that is, the portion of the machine which is normally attached to its surrounding or supporting structure.

A single cylinder engine may be taken as an elementary study in vibration. The moving parts in a single cylinder engine consist of the piston, connecting rod and crankshaft. Now the motion of the crankshaft is rotary, and a rotary motion can be balanced by rotary balance weights which are arranged of such mass as to bring the center of gravity of the crankshaft and balance weights as a whole exactly on to the crank axis. The piston has a straight line motion which cannot be compensated for, or balanced by a rotary part. The connecting rod may be regarded as partly rotational, and able to be balanced by a suitable increase to the balance weights on the crank, and partly reciprocating, thus adding to the effective weight of the piston and the amplitude of the vibration it causes. It is thus seen that the definite cause of vibration in a single cylinder reciprocating engine is its piston motion, which produces a counterpart linear vibration in the frame.

In multi-cylinder engines, the vibration due to the reciprocation of the pistons can be gotten rid of with more or less completeness and the most perfect in this respect are the engines fitted with eight cylinders and six cylinders, and the two-cylinders facing one another. The four-cylinder gets rid of the fundamental vibration due to the piston reciprocation. (We refer here to the customary arrangement as used in the four-cylinder cars of the present day with all cranks at 180 degrees.)

Vibration has frequently been attributed to the elasticity of the engine frame allowing a certain amount of spring when the cylinder pressure rises. The vibration that could be due to this cause is so slight as to be for all practical purposes negligible.

There is a kind of vibration which must be considered apart from that due to the inertia of the moving parts a above discussed; this is due to the want of uniformity i the turning movement or "torque." When the working cycl of an engine is intermittent, as is markedly the case in th internal combustion engine, there is at each impulse an augmentation of the velocity of the flywheel, and a rotational recoil acting on the engine frame, causing a kind of "kick"; this kick repeated with frequency results in a vibration. Th vibration due to rotational recoil can be minimized by employing a great number of cylinders, or by employing tw flywheels having opposite rotation.

In most cases the balancing of an engine to avoid vibration is a matter of compromise. Many of the causes of vibration are identical in a steam engine and in an interna combustion engine. An enormous amount of ingenuity ha been expended in the design of modern engines to neutraliz vibration as far as possible. These efforts have been almos entirely on the lines of a compromise, approximate balanc being all that has been aimed at. A reciprocating engine whic is balanced with scientific accuracy in every respect is th Lanchester, which is a two-cylinder engine with two crankshafts and two oppositely rotating flywheels. Lighter pistons and rods, smaller and multiplied cylinders, and bette general arrangement have considerably reduced vibration i modern cars, and the best suffer hardly at all from this cause except such as is set up by bad road surfaces.

Vibrator Adjustment—See Missing Explosions.

Vibrator, Broken—See Missing Explosions.

Vibrator Coil—A trembler coil. See Coil; Ignition.

Vibrator Points, Pitted—See Missing Explosions.

Victoria—A type of low carriage body, having a single sea for two passengers with an elevated seat behind for an attendant. It has an adjustable folding leather top called victoria top.

Victoria Phaeton—A carriage body combining the charac teristics of the victoria and the phaeton; seated for two, with a perch behind for a servant.

Vis-a-Vis—A light carriage body seated for two or four persons, the seats facing each other. (Pronounced "veez-avee.")

Viscosimeter—A device for measuring the viscosity of oils or other liquids.

Viscosity—A term applied in motoring to express the body or thickness of lubricating oils. See Lubrication.

Vise—A mechanical device, fixed or portable, for holding an object to be worked upon in a firm position under the operation of tools. See Tools.

Visible Steam—When dry steam is reduced to a certain temperature, it becomes partially condensed and is visible as a cloud of vapor which, in the case of motor cars traveling in the public streets, is objectionable and in most places prohibited by law.

To prevent visible steam, two methods are employed, either separately or together. One is to heat the steam before it leaves the car to such a degree that it is dissipated in the air before condensing, and becomes hardly noticeable. The other is to condense the steam to water so that it can be used again in the boiler, or simply ejected. There are objections to both methods.

The plan generally adopted in the smaller class of steam cars is to utilize as much of the heat of the exhaust steam as possible to raise the temperature of the feed water. Part of the steam is then diverted through condensers of small size, and reappears as water which trickles onto the road, the balance of the steam being discharged either through the smokestack, which helps to increase the draught of the furnace, or, before being discharged, reheated in the furnace. See Steam Cars.

Vitriol, Blue—Hydrous copper sulphate, also called copper vitriol.

Voiturette—A French term meaning a little carriage, generally applied by motorists and manufacturers to a two-seated car of small horse power.

Volt—The unit by which the "pressure" of an electric current is measured. It is scientifically defined as the difference of potential between the two ends of an electrical conductor having a resistance of one ohm, that will cause a current of one ampere to flow. See Ohm; Ampere.

Voltage—The pressure of an electric current measured with volts as units.

Voltage, Increasing—See under Battery.

Voltage, Low—See Misfiring, Causes and Treatment.

Voltaic Cell—A cell in which a voltaic current is produced; a galvanic cell. See Battery.

Voltameter—An instrument for measuring the work, and thus indirectly the strength, of an electric current. To be distinguished from a voltmeter, which measures pressure.

Volt-ammeter—An instrument which can be used for measuring either volts or amperes.

Voltmeter—An instrument for measuring the voltage, that is, the electrical pressure, or, as it is called, difference of potential, between any two points in an electric circuit. This pressure represented in volts is the amount of pressure available to send the current through any circuit. The voltmeter is largely used by motorists to measure the number of volts of an accumulator or battery. A voltmeter is an instrument of high resistance, and therefore takes very little current, but the magnetic effect of the small current which passes round it is used to deflect a needle and give the requisite indications upon a scale.

When testing with a voltmeter good contact must be made on the wires, otherwise extra resistance is introduced into the circuit and an erroneous reading obtained.

When a two-cell battery is tested, each cell should be taken separately if the reading is below four volts, as one cell may be given a higher reading than the other, but in the event of one cell giving one volt and the other two volts, the weaker cell will not discharge into the stronger, as the cells are in series. If the cells are joined together in parallel so that the two positives are joined together and the two negatives, then the stronger cell would charge the weaker until the voltage of each cell exactly balanced.

To obtain the exact working conditions of a battery by means of a voltmeter, it is desirable to take the voltmeter readings while a current is actually passing from the battery, as when cells are doing no work they will indicate a higher voltage than when current is passing, and the small current taken by the voltmeter is not sufficient to affect this.

Various forms of voltmeters are made and some are named according to the principle on which they work, as electrostatic, magnetic, and hot-wire voltmeters, etc.

Some types of voltmeter for motorists' use are made so that they take a working current in order to get an accurate reading of the voltage of the cell when at work, but, as a rule, it is not advantageous for a voltmeter to take current of any great quantity. See Ammeter; Battery.

Volumes, Metric—See Metric System.

Volute Springs—See Springs.

V-shaped Belt—A leather belt having a cross section like a letter V; used on motorcycles, etc.

V-shaped Motor—A double-cylinder motor having the cylinders arranged to resemble the letter V.

Vulcanite—A hard and non-elastic variety of vulcanized rubber. It contains from 30 to 60 per cent more sulphur and is subjected to a higher and more prolonged heat in curing than ordinary vulcanized rubber. The name is also sometimes applied to vulcanized fiber. Another name for vulcanite is ebonite.

Vulcanization—The process of treating caoutchouc, or crude indiarubber, with sulphur at a high temperature, by which its strength and elasticity are greatly increased, the changes in its properties resulting in either soft or flexible rubber or the hard rubber called vulcanite or ebonite, according to the degree of heat and the amount of sulphur used.

Vulcanized Fiber—A hard, red substance composed of vegetable fiber highly compressed and vulcanized under pressure in conjunction with some plastic substance and sulphur. It is used as an insulator, and is easily machined. Such parts as the bases of switches and the insulating parts of contact makers and distributers are very often made of it. It is also often used for washers for steam joints and hot gas pipes.

Vulcanized Tire Repairs—See "Tires" in Repairs and Adjustments; also under Care and Maintenance.

Vulcanizer, Portable—See under Care and Maintenance.

Vulcanizers—Appliances for vulcanizing rubber. Rubber in its raw state is more plastic than elastic. In order to take advantage of its elastic qualities it is necessary to amalgamate it with sulphur under great heat and pressure. If the pressure and heat are extended beyond a certain point, the rubber again loses its elasticity, and becomes hard and brittle. In the repair of automobile tires, either inner tube or casing, the old method of attaching patches by means of rubber solution becomes almost impracticable, except in the case of medium weight cars of moderate horse power, and in order to get a repair which will stand the heat and friction set up in motor car tires, it is necessary that the patch shall be vulcanized onto the existing rubber. For this purpose manufacturers have introduced small vulcanizing plants, which may be operated by a car owner on his own premises, or may be carried on the car. With some of these, repairs to a tire casing can be made without removing the tire.

The process of vulcanizing consists of amalgamating plastic rubber with sulphur in proper proportions, and subjecting it to considerable pressure and great heat. For this purpose an appliance is used which can be heated to the requisite temperature and has arranged on it clamps or other squeezing devices by which the pressure can be applied to the job in hand. The heat may be applied either by some form of burner—gas or oil—or by steam. It is generally considered that steam gives more even heat over all parts of the appliance than in the case where it is heated by an external flame, but for small repairs one system is practically as good as another, although in manufacture steam only is used.

W.

W—The chemical symbol for tungsten (wolframium).

Wabble—A rocking, unequal motion of a wheel when unevenly hung, or of a carriage top or hood when its supports are unsteady.

Wagon, Delivery—Motor delivery wagons are quickly coming into general use, the weight to be carried determining the type, strength, and H. P. of the chassis required.

Almost any type of chassis can be converted into a useful wagon for light loads, up to say three-quarters of a ton, by slight alterations, mainly by strengthening the springs and lowering the gearing, a speed of twelve miles an hour being ample. Where heavy loads have to be carried, however, the chassis must be specially designed for the purpose.

Wagonette—A light carriage having longitudinal seats facing each other, with a rear entrance, also one or two seats crosswise in the front.

Walking-Beam—The oscillating lever of a steam engine, reciprocating upon a center and forming the medium of communication between the piston rod and the crankshaft.

Want of Gasolene: Its Symptoms—See under Driving.

Warding File—A flat file of uniform thickness, cut only at the edges, used to file the ward notches in keys.

Warp—To turn or twist out of shape, or out of a straight direction, by contraction. The twist of wood in drying.

Washer, Pump—The cup-leather or piston packing of a pump.

Washers—Flat rings or perforated disks of metal or other material placed under a nut or pivot-head to prevent the metal underneath being damaged. Sometimes they take the form of a helical spring, which prevents the nut becoming loose. The following are some of the principal washers used in motor-car work:

Asbestos Washers.—These are used generally for insulating purposes, and sometimes for water joints; they are also used for unions, especially in steam-pipe connections.

Leather Washers.—These are not much used in motor-car practice, though sometimes they may be found in the ends of shaft bearings for the purpose of excluding dust.

Mica Washers.—Used solely for insulating purposes, and generally in the form of laminations to insulate the central "lead" of a sparking plug.

Split Washers.—A form of spring washer.

Spring Washers.—Washers which take the form of a helical spring and are used to lock a nut or bolt or stud, the nut being screwed down on the top of the washer. Where right-handed nuts are used, the helix of the washer is left-handed.

Washers for various purposes are frequently made of rubber as well as the materials mentioned above. Many parts and joints of machines and vehicles are protected or made tight by washers.

Washing a Car—See under Cleaning.

Washing Car Bodies—See under Carriage Work.

Washing out the Gear-Box—See under Lubrication.

Waste Cock—See under Cock.

Waste Pipe—A pipe used for conveying away waste steam or water; an overflow-pipe.

Water Circulating Pump—See Pumps.

Water Circulation—See Circulation; Care and Maintenance.

Water Circulation, Lack of—See under Loss of Power.

Water Cock—See Cocks.

Water Column—The column of water in a glass tube by means of which the height of water in the tank may be ascertained. Water columns are also used in gradometers to indicate the gradient; also in speed indicators to indicate the speed and in appliances for indicating the level of gasolene in gravity and pressure fed tanks.

Water Connections, Loose—See Miscellaneous Roadside Repairs.

Water Cooling—The system of cooling the cylinders of an internal combustion engine by means of water jackets, etc. See Circulation.

Water Cooling, Thermo-syphon—See Circulation.

Water Freezing in Generators, To Prevent—The eminent French chemist Leon Guillet asserts that a ten per cent addition of glycerine to the water used for the production of acetylene gas in generators will not prejudice the gas-making to any extent, although it may slacken it a trifle. This will prevent trouble from the formation of ice in very cold weather. If it is formed, gas cannot be generated, and the lights will be extinguished.

Water Gauge—A dial fixed to the dash to indicate the pressure of water in the circulation system due to the pump. By this means it is possible to tell whether the pump is working properly or not. Also called Manometer.

A gauge affixed to a steam boiler to indicate the depth of water therein.

Water in Carbureter—See under Carbureter.

Water in Gasolene—See under Gasolene.

Water Glass—The water gauge of a steam boiler.

Water Hammer—See under Hammer.

Water Jacket—The chamber cast round a cylinder, in which water circulates to keep the cylinder cool. The heat due to the explosion of the mixture rapidly radiates to, and is carried away by, the water. See Circulation.

Water Jacket, Repairing Cracked—See under Repairing.

Water, Lack of, in Tank—See Causes of Overheating, under Engines.

Water Meter—A water gauge; also an instrument that measures the quantity of water passing by it.

Water Pipes—The pipes through which the water for cooling the cylinders of an internal combustion engine circulates.

Water Pipes, Airlock in—See Causes of Overheating, under Engines.

Water Tank—See Tanks.

Water-tube Boiler—A form of boiler in which the water circulates through pipes and the flame wraps about them.

Waterproof Clothing—See Clothing; Dress, and Rubber.

Watt—An electrical term denoting the unit of energy. It is analogous to horse power in mechanical terms; 746 watts = 1 horse power. Volts × amperes = watts, hence the watt is also called volt-ampere.

Watt-hour—The electrical unit of work, equaling one ampere-hour multiplied by one volt.

Watt-meter—An instrument for measuring the power in any electrical circuit or work, generally a galvanometer that measures both difference of potential and quantity of current.

Weak Batteries—See under Loss of Power; also Missing Explosions.

Wear of Rear Wheel Bearings—See Causes of Overheating, under Engines.

Wear on Front Tires—See under Tires.

Wear, What to—See Clothing; Dress.

Web—A plain flat surface, as a sheet or thin plate of lead or other metal; the blade of a saw; the flat portion of a solid wheel, between the hub or nave and the rim; the arm of a crank, extending from the wrist to the shaft, etc.

Weber—In electricity, the practical unit of magnetic flux; named after Wilhelm Weber, a German physicist.

Weight—The quantity of a body ascertained by the balance; the measure of the force of gravity.

All modern standards of weight are based upon a cubic mass of water at its greatest density; thus the gram is equal to the weight of a cubic centimeter of pure water at its greatest density. The standard pound avoirdupois in the United States contains 453.59 grams.

Weight, Dead—The weight of a car when empty.

Weights and Measures—See Metric System.

Weld—The union of two pieces by welding; also the place of union or joint.

Weld, Scarf—A peculiar joint made in overlapping and welding two pieces of metal together. See Scarf.

Welding—A process by means of which two pieces of iron or metal are joined. The ends of the metal pieces are heated to white heat, and then hammered together, with a flux such as silver sand between, until they become a solid mass.

Welding, Electric—A method of welding in which the abutting ends of the two pieces of metal to be welded are heated by a current of electricity, while pressed together by mechanical force, in such a manner that there is a great and rapid accumulation of heat at the joint in consequence of the greater relative conductivity of the rest of the circuit.

Welding Heat—The heat at which iron begins to burn with vivid sparks.

Weld Iron, Weld Steel—Names sometimes given to wrought iron and wrought steel, but not generally adopted.

Welt—A strip of sheet iron riveted to two continuous plates, forming a butt joint.

Wet Battery—A primary battery in which, instead of a semi-solid electrolyte being used, as with the dry battery, a liquid is employed. Wet batteries are of many types, but are seldom used in connection with automobiling, except as charging agents for storage batteries.

Wet Steam—Steam in contact with the water from which evaporation takes place. Any ordinary boiler supplies "wet" steam, and in order to increase its sphere of usefulness superheaters are sometimes fitted. "Wet" steam retains its nature as a vapor; while dry or superheated steam pertains more to a purely gaseous condition.

Wheel—A circular frame or solid disk turning on an axis. The various kinds of wheels used in motor-car construction are described under Wheels, below.

Wheel, Artillery—See Wheels.

Wheel Base—The distance between the points where two road wheels, on the same side, touch the ground.

Wheel Bearings—See Bearings.

Wheel, Blank—A wheel having no teeth.

Wheel Boss—The portion of a shaft shaped or enlarged to receive a gear wheel, which is usually keyed thereon.

Wheel Brakes—Brakes which act directly upon a road wheel.

Wheel, Compression—See Road Wheels, under Wheels.

Wheel, Eccentric—See Eccentric.

Wheel, Front or Rear, Smashed—See Miscellaneous Roadside Repairs.

Wheel, Idle—See Idle Wheel.

Wheel, Multiplying—A form of multiplying gearing; a geared wheel for increasing the speed of a movement.

Wheel, Ratchet—See under Ratchet.

Wheels—Almost every variety of wheel may be found in some part or other of motor-car construction, and the most important of them are enumerated below:

Road Wheels.

The road wheels of motor cars may be classed under two heads—those which take the weight and those which have to take both the weight and the drive. All the road wheels of a motor car have to take weight—the weight of the car being distributed between the four wheels—but one pair of wheels always has to take the drive, and it is necessary in considering the construction of these wheels that provision should be made for this driving strain.

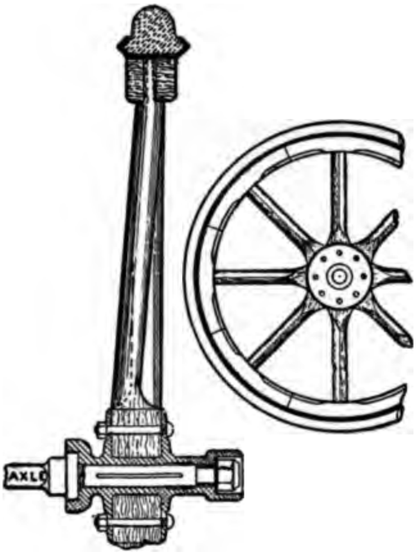
Road wheels may be divided into two classes—suspension wheels and compression wheels. In the first case the vehicle is practically hung upon wire suspension spokes, which are anchored in the rim and attached to the hub. Each spoke, or pair of spokes, in turn takes the weight of the car. In this style of wheel the spokes have to be "splayed"—that is, alternately run from the rim to one side or other of the hub, in order to give lateral stability to the wheel. These wheels will carry considerable weight in proportion to their own weight. If the spokes run radially from the hub to the rim the wheel is useless for taking a driving strain, and where these wheels are used for driving, the spokes have to run in a tangential direction. The wheel is then known as a tangent wheel, its principle being well exemplified in the ordinary bicycle wheel. Wire suspension wheels have been widely adopted for motor cars. In most cases, however, wooden compression wheels are used.

In the compression wheel, the spoke takes the weight of the car in the direction of its axis, being fixed in the hub and the wheel rim or felloe. In some cases in these wheels the spokes are splayed, much in the same way as in the wire wheels, but the splaying of the spoke does not increase the strength of the wheel to carry weight, but increases its lateral stability, and prevents its buckling under side strains, as when a car skids and comes up against some stationary obstacle, such as a curb.

Artillery Wheel.—As its name implies, this is a road wheel of the form used on gun carriages, whereon it is subjected to severe strains and shocks. It has been adopted in motorcar construction on account of its great strength in comparison with its weight. As will be seen from the sketch, it has a long bearing surface on the axle, which increases its wearing powers, and gives it greater steadiness. The wheel is dished outward somewhat—that is, the vertical center line through the tire does not coincide with that of the hub. This dishing gives the wheel greater lateral strength.

In some cases the wheel, though it may have a long hub, has vertical spokes and no dish in the wheel, the axles being bent downward slightly to conform with the curvature of the road surface. The same effect can be got in the case of the driving wheels with a live axle by the cambered axle. See Axle.

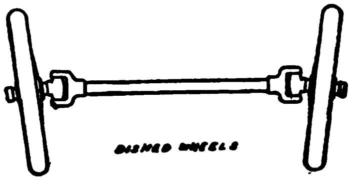
Chain Wheel.—The chain wheel, as its name implies, is a wheel which can drive, or be driven from, another wheel by a chain. It has on its periphery teeth which engage with the spaces in the chain. The toothed ring which is attached to the spokes of an artillery wheel to take the drive in the case of cars with side chain transmission is known as the chain ring. It has no hub, and only becomes a wheel proper when it is attached to the driving wheel of a car. The chain wheel at the end of the differential shaft or countershaft is known as the chain sprocket.



ARTILLERY WHEEL.

Crown Wheel.—Used to describe the major or principal wheel of bevel gearing. See Bevel Wheel.

Detachable or Demountable Wheels.—Wheels which can be attached or detached quickly to or from the hub. These detachable wheels allow of the carrying of a spare wheel complete, and considerably lessen the cares of the motorist in case of a punctured tire, as he can place a complete new wheel, with tire already inflated, upon the hub within a very short space of time. In the case of certain of these wheels, which are of the wire or suspension type, the saving in weight over detachable rims is very considerable.



The problem of making a quick change of wheels or tires so as to lessen the delay consequent upon tire punctures and other tire troubles has received the attention of many manufacturers, and there are numerous devices in the market for obviating such difficulties.

One device includes a "quick detachable tire" on a "universal" rim, also detachable, and this—with the use of an air bottle for rapid inflation of tires—is an equipment preferred by many motorists to the carrying of a complete spare wheel.

The objection to relying upon a spare wheel is that the motorist cannot count with certainty upon having only one case of trouble during a trip, and the argument for the detachable tire and rim is that it is no more trouble to remove, repair and replace the tire where such a rim is used than to attach the average spare wheel, which leaves the original trouble to be overcome on reaching the garage.

With the quickly detached rims and tires now offered, any one, no matter how inexperienced, can remove the tire and replace it in less than a minute. It is a simple, easy operation and the manufacturers estimated that more than 200,000 of these detachable rims would be used on new 1909 models alone.

Those who prefer complete emergency wheels can find them in the market in all sizes from 28-inch to 36-inch standard clincher or quick detachable wheels.

With the modern devices now available the puncture need no longer give the motorist a cold chill. It is only the work of a few minutes at the outside to replace the rim and tire or affix an emergency wheel, so that it has become a simpler task to overcome the difficulty of a puncture than to adjust a coil or fix a spark plug.

Gear Wheels.

A gear wheel is one which receives motion from one member and imparts it to another.

Bevel Wheel.—In this wheel the teeth lie at an angle to the axis of the wheel, and are used to transmit motion from one shaft to another lying at an angle. When this angle is a right angle, and the wheels are equal in diameter and number of teeth, the bevel wheel is known as a miter wheel. The smaller member of a pair of bevel wheels is called a bevel pinion.

Miter Wheel.—A bevel wheel having the face of the teeth at such an angle that they transmit the motion between two shafts at an angle of 90 degrees to each other, and whose angles are equal.

Spur Wheel.—A toothed wheel, generally of very small diameter. The name is used to differentiate between it and the large wheel which it drives. It is often known as a pinion.

Friction Wheels.

A friction wheel is one which either drives, or is driven from, another wheel by friction between the surfaces in contact. The two wheels may be placed with their axes parallel when the friction surface is composed of their peripheries. Or they may be placed at an angle, when the edge of one comes in contact with the face of the other. This latter type of wheel has sometimes been used for obtaining a variable speed. See Change Speed Gear. The former type is used for driving centrifugal circulating pumps. See Pumps.

Flywheels.

A flywheel is a wheel keyed or otherwise attached to the crankshaft of the engine. The object of a flywheel is to equalize the shocks and impulses given by the reciprocating pistons to the crankshaft. The larger the flywheel the more steady the running of the engine, for the flywheel acts as a reservoir for the energy, giving it out in a constant torque or twisting motion upon the shaft, instead of a series of sharp impulses, such as are given to the crankshaft by the expanding gases. In high speed engines, such as gasolene engines used in motor cars, the design of the flywheel has to be carefully considered, as if its diameter is made too large the centrifugal action set up is enormous, tending to burst it or tear it away from its spokes or central disk. For this reason it is generally made of good width, with a very thick rim of heavy weight, but not of very good diameter. The flywheel in most engines forms one member of the clutch for transmitting the power to the gear. See Clutch.

Other forms of wheel will be found described under their characteristic designations in their respective alphabetic places in the Cyclopedia, as Ratchet Wheel, Sprocket Wheel, Steering Wheel, etc.

Size and Strength of Wheels.

The actual diameter of the road wheels will, of course, vary with the class of car, but many experts think there is a tendency to make them too small. Not even a runabout car should have wheels less than 30 inches in diameter, while 34 inches makes a good size for an average. Small wheels are stronger in proportion for their weight, and the tires cost less in the first place, but larger wheels are less subject to road shocks, and the tires, having a larger surface, last longer.

As already indicated, the wheels must be strong vertically to carry the weight, and laterally to withstand centrifugal forces and pressure set up by running against curbs, projecting street-car tracks, etc. The lateral forces generally act on the wheels from the outside towards the longitudinal center line of the car. The driving wheels, in addition, must be strong tangentially to transmit the driving force and stand the application of the hub and gear brakes.

Wood Wheels vs. Wire.

As a rule, motor car wheels are constructed of wood and without any "dish"; the artillery wheel, however, which has a metal hub or nave, and which is sometimes slightly "dished" or concavo-convex, is very largely employed. In some the spokes are of a peculiar section, giving increased strength both laterally and tangentially.

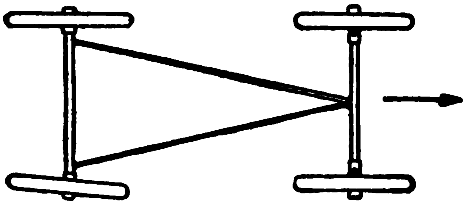
The wire wheel was in much more general use a few years ago than it is now, but it is showing some signs of returning to popular favor, especially for small cars. Its double-dished construction makes it very strong laterally, and the usual tangential arrangement of the spokes gives a high driving and braking efficiency. It is a good deal more trouble to clean than wooden wheels, and its appearance is open to discussion; but, on the other hand, it is much easier to replace a spoke in a wire wheel than in a wooden one, and the balance of weight is in favor of the wire wheel. As the parts of the rotating wheel move up and down as well as along, weight saved in the wheels is worth considerably more than the same weight saved in fixed parts of the car. Another point in favor of wire wheels is that owing to their lightness they ease the steering and one can also have large tires without increasing the total rotating weights, as what one adds in the larger tires one saves in the lighter wheels.

Shrinkage of Road Wheels.

A spell of dry weather often causes wood wheels of motor vehicles to shrink at the hubs and the felloes, and particularly on live axle cars this is likely to prove trying to the wheel's stability if not attended to. A good plan to prevent excessive shrinkage is to take a cloth and soak it well in water; then wrap it about the hub of the wheel where the spoke wedge centers fit up together. This will effectually prevent shrinkage at these points. At the felloes wet rags should be placed in the same manner, or the wheel should be frequently douched with water, but in the latter case after the wetting the tires should be wiped over to dry them, otherwise there is a tendency to cause rotting of the canvas by the penetration of any water through cuts in the rubber or through places in the beading where the water can penetrate. Another plan is that recommended by a motorist who filled every gap in the wheels, gaps in felloes, and gaps around the ends of the spokes with melted solder. This proved in his case a perfect cure for the trouble.

Road Wheel Adjustments.

There is no great difficulty attached to the adjusting of the road wheel bearings on a motor vehicle; yet, like everything else, there is a right and a wrong method of procedure in the operation. Any slackness of the bearings in the front wheels is usually visible, and, if not, is often perceptible at the steering wheel. In the rear driving wheels any looseness is rather more difficult to find, but it may be indicated frequently by an increased noise from the driving chains, as the wheels work backward and forward on their axles, constantly bringing the chain wheels into and out of line with the sprockets. If one has reason to believe that the wheels are in need of adjustment, the back axle should be jacked up clear of the ground, and the wheel tried. It will invariably be found that, though there is no actual side shake on the wheel, it will move



Wheels Out of Track.

backward and forward on its axle. In testing for slackness, one should always grasp the wheel by the spokes near the hub, and pull it backward and forward, thereby judging the amount of slackness in the bearing. To test the side shake, the spokes should be grasped near the rim top and bottom on a vertical line, not a horizontal, as the weight of the car is upon the bottom side of the axle, and while any side play is noticeable on the vertical line, it would not be so upon the horizontal, as there is practically no wear in this direction. As a matter of fact, the wear is not actually upon the bottom of the axle, it being about half way between the horizontal and vertical lines, toward the front of the axle. The same method of testing for slackness should be observed on each of the wheels, adjustments, of course, being made separately.

A Front Wheel Bearing Repair.

"Recently we had trouble with one of the front wheel ball bearings of a small car we were driving, the relation of which may serve others who may have to share our experience," writes a well-known motorist. "The trouble started with a ball breaking, and was first brought to our notice by a squeaking in the hub. On taking out the cone, the balls in one race were found to be almost all broken or flattened out, while the cup in the hub was also broken. We ran on slowly to the nearest town and put into a repairer's. As the repairman was unable to replace the cup, it was useless to put in a fresh set of balls, so we took out the balls on both sides, and drove a piece of pipe—as a matter of fact, a piece of cycle handle-bar—on to the axle, filled the hub with grease, placed the wheel back on the axle, and ran home on the piece of handle-bar as on a plain bearing. The wheel was kept on by means of the outer cone and lock-nuts. Our reason for putting a piece of tube on the axle was to prevent any damage to the axle itself, as in a previous instance we remember a ball breaking in one of the wheel bearings of a car in which we were driving. The driver thought he would risk it, and on taking down the wheel subsequently it was found that the broken balls and cup had cut half through the diameter of the axle.

Artillery Wheels out of Truth.

Some difficulty is experienced occasionally by the so-called artillery wheels going out of truth, either circumferentially or laterally, or both. When a wheel is noticed to be so affected, it should be attended to immediately, otherwise it is quite possible that it may be followed by an entire collapse. Truing up is a thing which cannot be attempted by the ordinary repairman, and must be put into the hands of a competent carriage-builder who makes his own wheels or who can get them trued up by a firm which makes a specialty of wheel-building. This going out of truth is caused chiefly by the wheels being built up with imperfectly-seasoned timber, which is greatly affected by atmospheric changes, causing fluctuations in the tension upon the wheel. This will expand in wet weather, while in dry seasons it contracts and tends to split apart at the felloe and at the junction of the spokes with that part, despite the fact that the whole is bound by the iron rim of the tire.

The Management of Ball Bearings.

So intent are many motorists on the management of their engines, electrical apparatus, etc., that important accessories, such as wheel bearings, are apt to escape the notice which they deserve. Ball bearings are only superior to the bearings commonly used in carriages when working efficiently. Therefore, it behooves the motorist to see that everything is in order by timely inspection. An engine working against unnecessary strain cannot do its best or work the longest. To insure the best results, nothing but good can come if a rule is made to examine the wheel bearings (especially the hind wheels) every 2,000 or 3,000 miles at least, and to renew the balls once yearly, or say every 5,000 or 6,000 miles. This would tend to greater economy, for steel balls are always cheaper to replace than the cups and cones on which they run, and this in the ratio of 1 to 5. The damage a broken ball may do, or, worse still, a ball worn sharp, as well as rough, is not easily appreciated by those who have no experience in this. Nor do such accidents reveal their occurrence to the driver as plainly as might be expected, even to a careful man.

Wheel, Stripping the—See under Care and Maintenance.

Wheel, Suspension—See Road Wheels, under Wheels.

Wheels and Tires, Examination of—See Overhauling Hints and Tips, under Overhauling.

Wheels, Artillery, Out of True—See under Wheels, above.

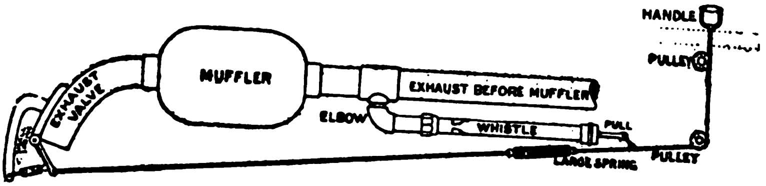
Wheels Out of Track—See under Steering Gear.

Wheels, Road, Shrinkage of—See under Wheels.

Whip—A term used of the slight bending of the frame of a long wheel-base chassis when it is driven over undulating or rough roads. If the bending is such as to lead to a permanent set, the term "whip" would not be applied. We then have distortion—the elastic limit of the material having been passed.

Whip-saw—A frame saw with a narrow blade, used to cut curved kerfs.

Whistle—An instrument or apparatus for producing a whistling sound, by a stream of air or of steam so directed through a tube as to impinge on a sharp edge. Whistles are used to some extent by motorists for signaling their approach.



The Nightingale Whistle.

The Nightingale whistle, the attachment of which is illustrated, is operated from the exhaust direct and has a chromatic scale of notes with a continuous trill described as "melodious, penetrating, and attractive." It can be attached to any car, either to the exhaust pipe by means of an elbow (with the use of a tee if necessary) or to the muffler direct. Its tones vary from "a low melodious town signal to a noise that penetrates for over a mile."

White Copper—One of the many names of German silver.

White Heat—The state of metals or of some non-metallic substances, as carbon, in which they radiate a white light when heated to a high temperature.

White Lead—See under Lead.

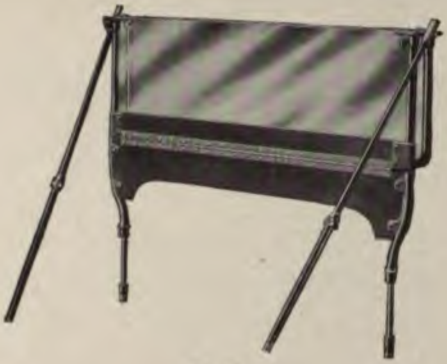
White Metal—An alloy principally composed of lead and antimony in varying proportions, with traces of zinc, iron, copper, and bismuth.

This metal (often called anti-friction metal), is used for lining or bushing the bearings of crank shafts, piston rods, and speed gear bearings, etc. It forms a very fine, smooth surface, easily scraped to make a perfectly true and even bearing. According to the proportions of the different metals in the alloy, it melts at different temperatures, and in some cases the melting point is so low that it can be applied to the bearing with a hot soldering iron, while in others it has to be melted first in a ladle, and poured into the bearing, being afterwards machined to the required size.

Great care must be taken that any bearings lined with anti-friction metal are very well lubricated and fitted, as any undue heat from excessive friction will melt out the alloy, and leave the bearing in such a condition that other parts depending on the bearing may be seriously damaged in a very short time.

White Steam Car, The—See under Steam Cars; also The Steam Car, under Motor Car.

Whitworth Standard—A British standard scale of screw threads setting out the number of threads per inch for screws, bolts, nuts, etc., and also determining the angle, the amount



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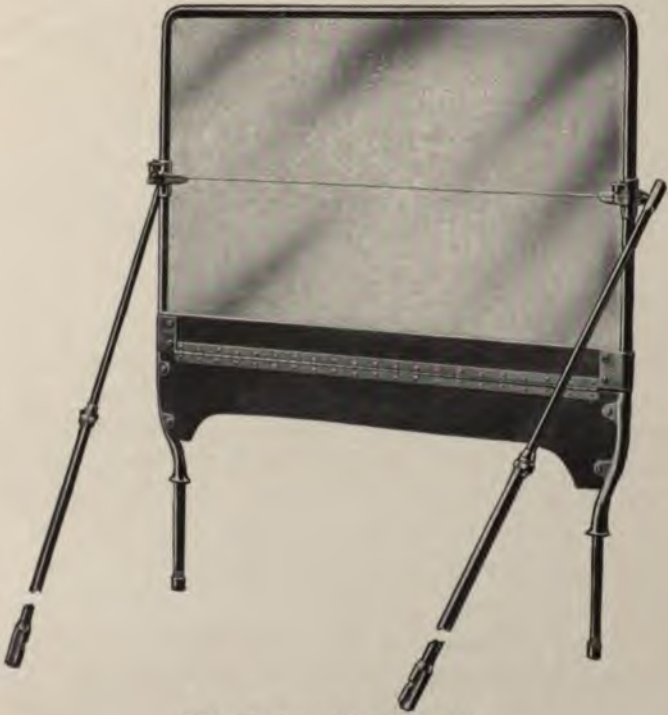


The Banker Wind Shield.

of clearance top and bottom and the shape of the top and bottom of the threads.

Wick—A number of threads of cotton or some spongy substance loosely twisted together or braided or woven into a fabric. Used in oil lamps to supply the oil to the burner by capillary attraction; also used in some forms of carbureters. See Lamps; Carbureter.

Wick Carbureter—See Carbureter.

Windage, Effect of—See Economizing Gasolene.

Winding Armature—See under Coil; Ignition.

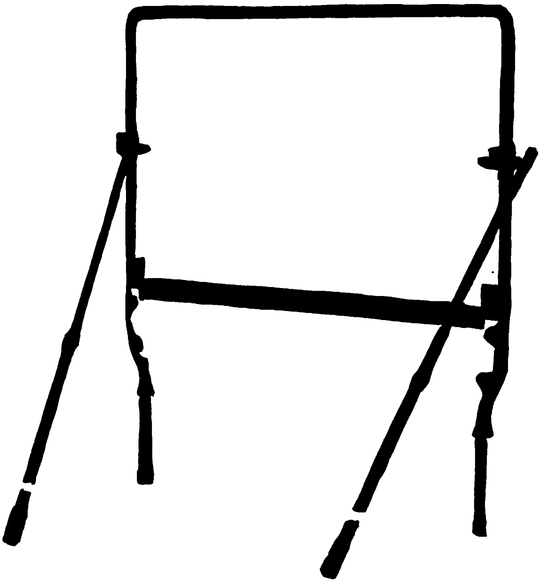
Wind Resistance—The wind resistance of a moving body of a given area increases as the square of the velocity. Experiments have shown that with the large bodies of motor cars, such for example as the limousine, the increased power required for increased speeds is out of all proportion to the increased power for such increased speeds with cars having less surface area, such as cars using ordinary touring bodies.

Wind Screen—See Wind Shield.

Wind Shield—Wind shields or screens of plate glass are often used in front of cars, especially of the touring class. They prevent the rush of wind in the face when the car is traveling fast, and dispense with the necessity of wearing ugly goggles and face masks. Sometimes they are made to fold down in two pieces. In fine weather they do not affect the driving, but in rain, sleet, and snow they may impede the outlook and render driving uncomfortable and even dangerous owing to the glass becoming splashed with snow and rain. Some drivers object that a shield causes a more or less unpleasant draught on the back of the head.

The best height for a wind shield is such that the driver can just see over the top. It is quite as good a protection from rain and wind as the higher variety.

In order to prevent injury, should the glass become smashed by accident, screens may be made of patent glass with fine wire netting embedded in the glass in the course of manufacture.



The Banker Wind Shield.

Wing—One of the mudguards of metal, etc., placed over the road wheels to save the occupants and the body of a car from being spattered with mud picked up by the wheels.

A thin broad projecting piece on a gudgeon, to prevent it from turning in its socket.

Wing-iron—One of the irons by which a wing or mudguard is attached to the body or frame of a car.

Wing Nut—See Bolts and Nuts.

Winter Care of Tires—See under Tires.

Winter Treatment for Engine—See under Lubrication.

Wipe Contact—The method of making and breaking the primary circuit on a motor by means of a brush bearing on an insulating disk having a conducting segmental insertion, which comes under the brush at every revolution. There are many variations of the brush arrangement. See Contact Maker; Contact Breaker; Distributer; Ignition.

Wipe Contact Breakers—See under Ignition.

Wiper—An appliance which wipes against some rotating part. In many modern forms of contact maker or contact breaker a revolving wiper rubs against the inside of a ring containing insulated segments so as to make intermittent contact. Wipers are also used to keep in contact with an insulated ring to take current off a magneto or distributer. See Ignition.

Wipe Spark—See under Ignition.

Wire—A slender bar or elongated body of metal, commonly circular in section and varying in size down to a fine thread. Drawn from metals by powerful machinery and passed through a series of holes of gradually diminishing size.

The different classes of wire used in motor-car construction are as follows:

Brass Wire.—This wire is sometimes used to bind different members together.

Conducting Wire.—Any wire used to conduct or convey an electric current.

Copper Wire.—Copper wire is used for all electric wiring, as it is one of the best conductors obtainable. Silver is a better conductor, but owing to its cost it is not often adopted for electrical work. Bare copper wire is also useful for many purposes, such as binding on the rubber pipe connections of the water system, etc.

Flexible Wire.—Flexible wire is composed of a number of fine wires incased in an insulated covering, forming one cable. By this method of arrangement the wire can be twisted about as much as desired, as the built-up cable does not break through constant bending.

Fuse Wire.—A wire composed of a lead alloy with a low melting point; or a fine copper wire. It is inserted in series in a circuit, and is so proportioned to the current flowing in the circuit that should the current become too great for the wire of the circuit to carry, the heat generated by its resistance to the increased current immediately fuses or melts it and thus opens the circuit.

Ground or Earth Wire.—This term is applied to the wire used to connect the "ground" terminal of the coil to any part of the engine or frame, thus completing the circuit through the metal work of the car. "Ground" or "earth" is simply a term used to describe a large mass used as a return circuit, although in the case of telegraphy the earth is actually used.

Insulated Wire.—A wire which is covered by a material which prevents the current from short circuiting. Indiarubber is one of the best and commonest materials used for insulation on account of the high resistance it offers to a current of electricity. Paper and silk are also in every-day use for the same purpose, but being absorbent they are either protected by a waterproof material or used in positions that are not exposed to wet.

Wires for carrying a current are first covered with a thin coating of rubber, then a thicker layer of paper, cotton, silk, etc., and lastly a coating of heavy braid impregnated with a waterproofing solution. The thickness of the coating of insulating and protective material depends on the current which the wire is intended to carry, and the purpose and position in which it is to be used. The tension or voltage of the current is a very important factor in determining the quality and quantity of the insulation used, as the higher the voltage the greater power the current has to break down in order to pierce the insulation. In positions exposed to great heat a different kind of insulation has to be used. For instance, to insulate the central wire of spark plugs, a material which is not affected by heat is adopted: this is generally porcelain or china, but layers of mica also make excellent insulators. The fine wire used in the secondary circuit of induction coils is always insulated with a winding of fine silk thread.

Iron Wire.—The core of an induction coil is composed of a bundle of fine soft iron wires as these are easily magnetized and as easily demagnetized. See Coil.

Negative Wire.—The insulated wire leading from the negative terminal of some source of electrical current.

Platinum Wire.—Platinum wire is inserted into the points of two members between which a spark is intended to jump. This metal is used because its melting point is extremely high, so that it does not readily become pitted.

Positive Wire.—The insulated wire leading from the positive terminal of some source of electric current.

Primary Wire.—The thick insulated wire winding of an induction coil, wound on next to the core. The current is passed through this wire, giving rise to induced currents in the secondary wire wound over it. See Coil.

Secondary Wire.—The wire of an induction coil in which the high tension current is induced. See Coil.

Steel Wire.—A good many light operating levers, such as throttle levers, are made of stout steel wire. It is also used as spokes for wire wheels. Wire cables also are usually made of steel wire.

Wire Belt—A machinery belt made of wire instead of leather.

Wire, Broken—See Missing Explosions.

Wire, Broken or Disconnected—See under Motor Stopping.

Wire Cable—A rope composed of a number of steel wires, which gives it great flexibility combined with strength. It is used in a great number of cars for operating the brakes, and also in the Bowden patent mechanism.

Wire Cloth—Same as Wire Gauze.

Wire, Conducting—See Electric Conductors.

Wiredrawing—The operation of drawing or extending ductile metals into wire. The metal, after being hammered into a bar, is drawn successively through a series of holes of diminishing diameter in a hardened steel plate, until the requisite degree of fineness is obtained.

Wire Edge—A thin wire-like edge on a cutting tool, made by oversharpening it on one side.

Wire, Electric—A wire for conducting a current of electricity, usually of copper insulated.

Wire, Extra Grounding—See under Ignition.

Wire, Flexible—An electrical conductor consisting of a number of fine wires twisted into a cable and covered with silk or other insulation.

Wire, Fuse—See Fuse Wire, under Wire, above.

Wire Gauge—See Gauge.

Wire Gauze—A finely woven material the weft and warp of which are formed of very fine brass wire so as to allow a liquid to pass through but to intercept small solids or other matter. It is used for filters for water, gasolene, oil, and exhaust gases. For gasolene the mesh of the gauze should be so fine that water will not pass through it unless forced with considerable pressure. This precludes the possibility of particles of water being passed through with the gasolene, and thus interfering with the action of the carbureter. See Carbureter: Filter.

Wire Off—See Missing Explosions.

Wire Rope—See Wire Cable.

Wires, Oil-soaked Secondary—See Loss of Power.

Wires, Wet—See Missing Explosions.

Wire Wheels—See Road Wheels, under Wheels.

Wiring—Some system of wiring is necessary in a motor car to provide a complete circuit or path for the electric current used for ignition purposes between the two terminals of the source of supply, and insulated wiring is necessary in part of that circuit, in order to insure the current following that path, so that it may perform its required duties only under the control of the driver. The method of wiring is governed partly by the type of ignition adopted, partly by the apparatus used to obtain that ignition, and partly by the individual fancy of the manufacturer. Both high and low tension systems are used for igniting the charge, the former by a high voltage current capable of causing a spark to pass from one point to another through the compressed gas in the cylinder, the latter producing a low tension spark by, and at the moment of, breaking contact between two conductors placed in the cylinder.

Storage batteries, dynamos, or wet or dry cells have each two free terminals for wiring up, and the contact breaker one terminal for each cylinder, and possibly, a grounding terminal as well. All these have to be connected up so as to form, with the high tension circuit from the coil, two complete circuits, one high and the other low tension.

With the magneto low tension system only one wire is required from the magneto to the sparking arrangement in the cylinder head, the rest of the circuit being completed by the metal parts of the motor and the magneto.

The wiring of motor cars is so simple that it is often done carelessly. Good wiring should practically last as long or longer than any other part of the car's mechanism, but even with the great improvements that have taken place in using properly-insulated and flexible wiring, the manner in which it is fitted is far too haphazard. Wiring in motor cars has to endure extremes of heat and cold, water, mud, dust, oil, and grease, besides friction and mechanical injury, all of which are calculated to cause serious injury either to the wire itself or to its insulation; yet often no serious attempt is made to protect the wires, or even to place them in the best position, and secure them in a proper manner. See Ignition; Repairs and Adjustments.

Wiring and Ignition Failure—See under Ignition.

Wiring Cells in Series and in Parallel—See under Battery.

Wiring Systems with Trembler Coil—See General Summary, under Ignition.

Withdrawing the Clutch—See under Driving.

Wolfram—Another name for the metal tungsten, but more properly applied to a native tungstate of iron and manganese

—the ore from which tungsten or wolframium is usually obtained.

Wood, A Glue for—See Glue and Cement.

Wood Alcohol—See Alcohol.

Wood Alcohol as Anti-freezing Mixture—See Anti-freezing Solutions.

Wood Frames—See Frame.

Wood Screw—A screw for fastening together parts of wooden structures or wood and metal. Wood screws usually have a boring point and are distinguished from machine screws, used in metal alone, in threads bored to receive them.

Wood Wheels—See Road Wheels, under Wheels.

Work—In mechanics, work is defined as "the product of a force by the component displacement of its point of application in the direction of the force." Mechanical work is "work done in the displacement of sensible masses, as opposed to work done in the displacement of molecules."

In physics and chemistry, work is the production of any physical or chemical change, as when a body is heated or when a compound is decomposed by electrolysis, etc.

See Efficiency; Force, etc.

Working-beam—Same as Walking-beam, which see.

Working Point—That part of a machine at which the effect required is produced.

Workshop—A separate workshop is almost a necessary part of an up-to-date garage, where more than one car is kept in constant use.

It is of the greatest importance that it should be well lighted —preferably by roof lights from above, and well ventilated, as such work as vulcanizing, soldering, brazing, etc., may require to be done in it. There should be plenty of bench room, the bench being solid and stiff and well cemented in wall and floor. Also racks, cupboards, shelves, and pigeonholes should be provided, so that the mechanic or chauffeur can work in freedom and comfort on a clear bench. For the equipment of the workshop as regards tools and appliances, see under Tools, etc.

Working up the Bearings—See Overhauling Hints and Tips, under Overhauling.

Worm—A rod or shaft having turned on it a spiral or screw thread. See Steering Gear.

Worm and Sector—Same as Worm and Segment.

Worm and Segment—A mechanical device used in steering motor cars, illustrated under Steering Gear.

Worm Drive—See Gear or Gearing.

Worm Gear—A gear wheel having teeth so formed that they are acted on and the wheel revolved by a worm or shaft on which a spiral is turned.

Worm Wheel—Same as Worm Gear.

Wrench—A tool of various forms, but consisting essentially of a metal bar having jaws at one end adapted to catch upon the head of a bolt or a nut, or to hold and turn a metal pipe or rod. Some wrenches are made with a series of graduated jaws to fit various sizes of bolts and nuts, as alligator wrenches and machinists' wrenches. Others have adjustable jaws, as monkey wrenches and pipe wrenches. Spanners are certain forms of the wrench. See Tools, etc.

Wrench-hammer—A hammer with a movable jaw which can be used as a spanner.

Wrist Pin—In machinery, any pin which connects a pitman to a cross-head or crank. The term is applied in motor-car practice to the piston pin or gudgeon pin. See Piston Pin, under Pins.

Wrought Iron—Cast iron which has been puddled, and which is drawn out in bars or sheets through rollers while in a semi-liquid state. It is distinguished from the ordinary cast iron in that it has a grain running lengthwise and is not crystalline. It is easily bent, but under vibration rapidly becomes crystalline and may fracture, and is, therefore, very seldom used in any part of a motor vehicle. Mild steel or cast steel takes its place for automobile purposes.

X

X—The Roman numeral for ten. In mathematics, "x" is the first of the unknown quantities or variables.

Xylene—A volatile, inflammable liquid obtained from wood-spirit and from coal-tar; one of the benzines.

Xylonite—Another name for celluloid, an acid-resisting, non-conducting composition, used in switches and other electrical appliances.

Y—In mechanics, the component of a force in the direction of the axis of "y."

Y—A forked clamp for holding drills or other tools; a two-way pipe or coupling; a Y-pipe or Y-cross.

Yard—The fundamental unit of English long measure (36 inches), to which United States usage conforms. The mile contains 1,760 yards.

Yoke—A branch pipe or two-way coupling for pipes. A carriage clip for uniting two parts of the running-gear. A double journal-bearing, including two journals connected by bars or rods that pass on each side of the pulley, the shafting being supported by both journals; used in some dynamos to carry the armature. A cross-bar joining the ends of two parallel cores to form a horseshoe magnet.

Yoke-arbor—A form of double journal box for pulley spindles, having a curved arm extending from one bearing to the other on each side of the pulley and serving to protect the belt from chafing.

Yoke, Spring—A form of car-spring saddle shaped like an inverted U.

Z

Zero—The origin of measurement upon thermometers and similar scales. In electricity, the state of absolute rest when no current is flowing.

Zinc—A metal of comparatively recent importance in the arts and industries. It is more tenacious than lead and tin, but is malleable only at a temperature between 200° and 250° Fahrenheit. In combination with copper it forms brass and it is also one of the ingredients of German silver. The commercial name of zinc in ingots is spelter.

Zinc is used as the negative element in primary batteries. See Battery. It is also used to "kill" spirits of salts in order to form a flux for soldering purposes. See Tools.

To Paint on Zinc with Oil Colors.—Prepare zinc by treating it with a mixture of nitrate of copper, 1 part; chlorid of copper, 1 part; sal ammoniac, 1 part; hydrochloric acid, 1 part; water, 64 parts; and when a white coat has been formed by this treatment and dried on the zinc, apply the color.

Zincking—The operation of coating iron, etc., with a weak solution of sulphate of zinc, or one of the double salts of chlorid of zinc and sal ammoniac.

Zincode—The negative pole of a voltaic battery; the anode of an electrolytic cell.

Zinc-plating—Plating with zinc, the articles being immersed in a preparation made of coarse rasped or granulated zinc boiled in a mixture of sal ammoniac and water. The deposit has a silvery brightness and can be used as a first coat for articles to be twice plated, since any other metal can be deposited upon zinc.

Zinkite—A native oxid of zinc, also called red zinc ore.

Zn—The chemical symbol for zinc.

Zone—A belt or band around anything, as a stripe of different color around a carriage body.

Zylonite—Same as Xylonite, another name for celluloid.

Z

[illegible]

TABLE OF SPEEDS PER HOUR.

Time. min.	Time. sec.	Speed. miles.	Speed. yards.	Time. min.	Time. sec.	Speed. miles.	Speed. yards.
6	0	10	0	1	30	40	0
5	0	12	0	1	20	45	0
4	0	15	0	1	15	48	0
3	45	16	0	1	12	50	0
3	20	18	0	1	6	54	960
3	0	20	0	1	0	60	0
2	45	21	1440	0	50	72	0
2	30	24	0	0	48	75	0
2	15	26	1173	0	45	80	0
2	0	30	0	0	40	90	0
1	45	34	503	0	36	100	0
1	40	36	0				

REVOLUTIONS OF WHEELS PER MILE.

[In practice, pneumatic-tired wheels travel one or two per cent more revolutions than those given.]

Diameter of wheels.	Revolutions per mile	Diameter of wheels.	Revolutions per mile
26 in.	775½	34 in.	593
28 in.	720	36 in.	560
30 in.	672	38 in.	530½
32 in.	630	40 in.	504

HYDROMETER READINGS.

The following table shows what the hydrometer or densimeter should read at various temperatures with good gasolene:

Fahr.	Hydrometer reading.	Fahr.	Hydrometer reading.
32°	694	64°	678
40°	690	66°	677
50°	685	68°	676
60°	680	70°	675
62°	679		

and so on, .001 point less for every 2° more in temperature, but the gasolene sold is often some .03 or .04 heavier than this and is quite serviceable.

EQUIVALENTS OF MILES PER HOUR
in Minutes per Mile and Feet per Second.

Miles an hour		Minutes per mile	Ft. per second	Miles an hour		Minutes per mile	Ft. per second	Miles an hour		Minutes per mile	Ft. per second
8	=	7.30	11¾	43	=	1.23 3/5	63¼	72	=	50	105¾
15	"	4	22	44	"	1.21 4/5	64½	73	"	49 2/5	106¼
16	"	3.45	23½	45	"	1.20	66	74	"	48 3/5	108¾
17	"	3.31 4/5	25	46	"	1.18 1/5	67½	75	"	48	110
18	"	3.20	26½	47	"	1.16 3/5	69	76	"	47 2/5	111½
19	"	3.09 2/5	28	48	"	1.15	70½	77	"	46 4/5	112¾
20	"	3.00	29½	49	"	1.13 3/5	71¾	78	"	46 1/5	114¾
21	"	2.51 2/5	31	50	"	1.12	73¼	79	"	45 3/5	115¾
22	"	2.43 3/5	32¼	51	"	1.10 3/5	74¾	80	"	45	117¼
23	"	2.36 3/5	33¾	52	"	1.09 1/5	76¼	81	"	44 2/5	119
24	"	2.30	35¼	53	"	1.07 4/5	78	82	"	43 4/5	120½
25	"	2.24	36¾	54	"	1.06 1/5	79¾	83	"	43 2/5	121¾
26	"	2.18 3/5	38¼	55	"	1.05 2/5	81	84	"	43	122¾
27	"	2.13 1/5	39¾	56	"	1.04 1/5	82¼	85	"	42 2/5	124½
28	"	2.08 3/5	41	57	"	1.03 1/5	83½	86	"	42	125¾
29	"	2.04 1/5	42½	58	"	1.02 1/5	84¾	87	"	41 2/5	127½
30	"	2.00	44	59	"	1.01 1/5	86¼	88	"	41	128¾
31	"	1.56 1/5	45½	60	"	1.00	88	89	"	40 3/5	130¼
32	"	1.52 3/5	46¾	61	"	59	89½	90	"	40	132
33	"	1.49 1/5	48½	62	"	58 1/5	90¾	91	"	39 3/5	133½
34	"	1.45 4/5	50	63	"	57 1/5	92¼	92	"	39 1/5	134¾
35	"	1.42 4/5	51¼	64	"	56 1/5	94	93	"	38 4/5	136
36	"	1.40	52¾	65	"	55 2/5	95¼	94	"	38 2/5	137½
37	"	1.37 2/5	54	66	"	54 3/5	96¾	95	"	38	139
38	"	1.34 4/5	55¾	67	"	53 4/5	98¼	96	"	37 3/5	140½
39	"	1.32 1/5	57¼	68	"	53	99½	97	"	37 1/5	142
40	"	1.30	58½	69	"	52 1/5	101¼	98	"	36 4/5	143½
41	"	1.27 4/5	60¼	70	"	51 2/5	103	99	"	36 2/5	145
42	"	1.25 4/5	61½	71	"	50 3/5	104½	100	"	36	146½

FRENCH OR METRIC MEASURES.

The metric unit of length is the meter = 39.37 inches.
The metric unit of weight is the gram = 15.432 grains.
The following prefixes are used for subdivisions and multiples:

Milli = $\frac{1}{1,000}$, Centi = $\frac{1}{100}$, Deci = $\frac{1}{10}$, Deca = 10, Hecto — 100, Kilo = 1,000, Myria = 10,000.

FRENCH AND AMERICAN EQUIVALENT MEASURES.

LENGTH.

French.	U. S.
1 meter	= 39.37 ins., or 3.28083 ft.; 1.09361 yds.
.3048 meter	= 1 foot.
1 centimeter	= .3937 inch.
2.54 centimeters	= 1 inch.
1 millimeter	= .03937 inch, or 1-25 inch nearly.
25.4 millimeters	= 1 inch.
1 kilometer	= 1093.61 yards, or 0.62137 mile.

WEIGHT.

French.	U. S.
1 gram	= 15.432 grains.
.0648 gram	= 1 grain.
28.35 grams	= 1 ounce avoirdupois.
1 kilogram	= 2.2046 pounds.
.4536 kilogram	= 1 pound.
1 tonne or metric ton 1,000 kilograms	= .9842 ton of 2,240 pounds. 19.68 cwts. 2,204.6 pounds.
1.016 metric tons 1,016 kilograms	= 1 ton of 2,240 pounds.

CAPACITY.

French.	U. S.
1 liter (= 1 cubic decimeter)	= 61.023 cubic inches. .03531 cubic foot. .2642 gal. (American). 2,202 lbs. of water at 62 deg. F.
28.317 liters	= 1 cubic foot.
4.543 liters	= 1 gallon (British).
3.785 liters	= 1 gallon (American).

SPECIFIC GRAVITY OF GASOLENE
at Various Temperatures.

Fahr.	Sp. Gr.	Fahr.	Sp. Gr.
0°	.7088	46°	.6867
1°	.7083	47°	.6862
2°	.7078	48°	.6857
3°	.7073	49°	.6852
4°	.7068	50°	.6848
5°	.7064	51°	.6843
6°	.7059	52°	.6838
7°	.7054	53°	.6833
8°	.7049	54°	.6828
9°	.7044	55°	.6824
10°	.7040	56°	.6819
11°	.7035	57°	.6814
12°	.7030	58°	.6809
13°	.7025	59°	.6804
14°	.7020	60°	.6800
15°	.7016	61°	.6795
16°	.7011	62°	.6790
17°	.7006	63°	.6785
18°	.7001	64°	.6780
19°	.6996	65°	.6776
20°	.6992	66°	.6771
21°	.6987	67°	.6766
22°	.6982	68°	.6761
23°	.6977	69°	.6756
24°	.6972	70°	.6752
25°	.6968	71°	.6747
26°	.6963	72°	.6742
27°	.6958	73°	.6737
28°	.6953	74°	.6732
29°	.6948	75°	.6728
30°	.6944	76°	.6723
31°	.6939	77°	.6718
32°	.6934	78°	.6713
33°	.6929	79°	.6708
34°	.6924	80°	.6704
35°	.6920	81°	.6699
36°	.6915	82°	.6694
37°	.6910	83°	.6689
38°	.6905	84°	.6684
39°	.6900	85°	.6680
40°	.6896	86°	.6675
41°	.6891	87°	.6670
42°	.6886	88°	.6665
43°	.6881	89°	.6660
44°	.6876	90°	.6656
45°	.6872		

A.L.A.M. HORSE-POWER RATING

The formula adopted is $\frac{D^2 \times N}{2.5}$ and based on 1000 feet per minute piston speed. D is the cylinder bore, N the number of cylinders, and 2.5 a constant, based on the average view of the Mechanical Branch as to a fair conservative rating.

TABLE OF HORSE-POWER FOR USUAL SIZES OF MOTORS, BASED ON A.L.A.M. FORMULA

BORE		HORSE-POWER			
INS.	M/M.	1 CYL.	2 CYLS.	4 CYLS.	6 CYLS.
2 1/2	64	2 1/2	5	10	15
2 5/8	68	2 3/4	5 1/2	11	16 1/2
2 3/4	70	3	6	12 1/16	18 1/8
2 7/8	73	3 5/16	6 5/8	13 1/4	19 7/8
3	76	3 5/8	7 1/4	14 3/8	21 5/8
3 1/8	79	3 15/16	7 13/16	15 5/8	23 7/16
3 1/4	83	4 1/4	8 1/2	16 15/16	25 3/8
3 3/8	85	4 9/16	9 1/8	18 1/4	27 3/8
3 1/2	89	4 15/16	9 3/4	19 5/8	29 3/8
3 5/8	92	5 1/4	10 1/2	21	31 1/2
3 3/4	95	5 5/8	11 1/4	22 1/2	33 3/4
3 7/8	99	6	12	24	36 1/16
4	102	6 3/8	12 3/4	25 5/8	38 3/8
4 1/8	105	6 13/16	13 5/8	27 1/4	40 13/16
4 1/4	108	7 1/4	14 1/2	28 15/16	43 3/8
4 3/8	111	7 5/8	15 5/16	30 5/8	45 15/16
4 1/2	114	8 1/16	16 1/4	32 3/8	48 5/8
4 5/8	118	8 9/16	17 1/8	34 1/4	51 3/8
4 3/4	121	9	18	36 1/16	54 3/16
4 7/8	124	9 1/2	19	38	57
5	127	10	20	40	60
5 1/8	130	10 1/2	21	42	63
5 1/4	133	11	22	44 1/16	66 1/8
5 3/8	137	11 9/16	23	46	69 5/16
5 1/2	140	12 1/16	24 1/4	48 3/8	72 5/8
5 5/8	143	12 5/8	25 5/16	50 5/8	75 15/16
5 3/4	146	13 1/4	26 1/2	53	79 3/8
5 7/8	149	13 13/16	27 5/8	55 1/4	82 13/16
6	152	14 3/8	28 3/4	57 5/8	86 3/8

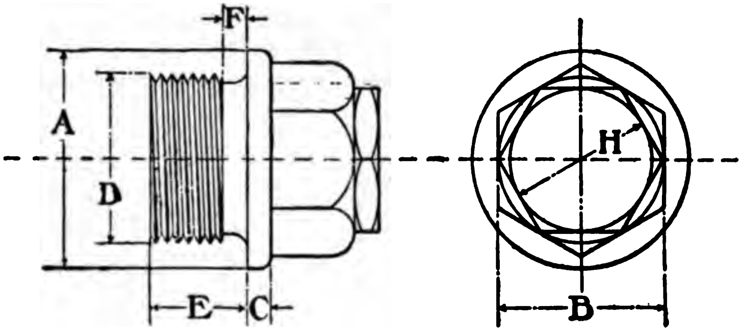
To simplify reading of the above, the horse-power figures are approximate, but correct within one-sixteenth.

January, 1909

Association of Licensed Automobile Manufacturers
7 East Forty-second Street, New York, U. S. A.

A. L. A. M. STANDARD SPARK PLUG.

The spark plug adopted as a standard by the A. L. A. M. has a ⅞ inch diameter, straight thread, 18 pitch, and the design and dimensions shown in the following drawing and specifications:



A—One and One-eighth Inch (1⅛")
B—Seven-eighths Inch (⅞")
C—One-eighth Inch (⅛")
D—Seven-eighths Inch (⅞")
E—Not Less than One-half Inch (Min. ½")
F—Not More Than One-eighth Inch (Max. ⅛")
(Depth of Recess—Not Over Depth of Thread.)
H—Three-quarters Inch (¾")

SPECIFICATIONS.

Stock—1⅛ inch round.

Head Form—Milled Hex. Short Diameter—⅞ inch.

Flange—Form—Circular. Diameter—1⅛ inch. Thickness —⅛ inch. Face—Annular seat ⅛ inch wide. (Suitable for McKim type copper-asbestos gasket.)

Blank for Thread—Diameter—⅞ inch. Length—Not less than ½ inch.

Recess Adjacent to Flange—Width—Not over ⅛ inch. Depth—Not over depth of thread.

Thread—Diameter—⅞ inch straight. Pitch—18. Form—U. S. standard. Cut—Perfect into recess.

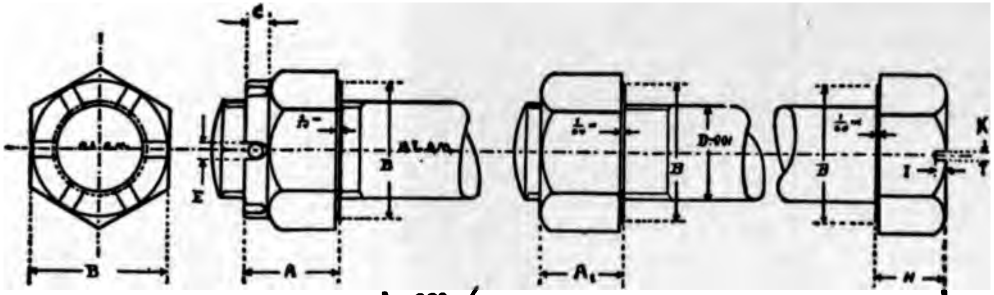
Packing-Gland Nut Head—Form—Hexagonal. Short Diameter—¾ inch.

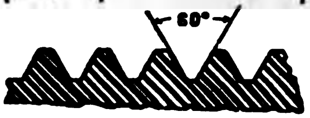
Association of Licensed Automobile Manufacturers.

STANDARD FOR

HEXAGON HEAD SCREWS, CASTLE AND PLAIN NUTS.

The following drawings and table (from Mechanical Branch Bulletin, No. 18) give in summarized form details as to the screws and nuts:





B refers to all nuts and screw heads.

d—Diameter of cotter pin.

D x 1.5—Length of threaded portion.

P—Pitch of thread.

$\frac{P}{8}$—Flat top.

D	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1
P	28	24	24	20	20	18	18	16	16	14	14
A	9/32	21/64	13/32	29/64	9/16	39/64	23/32	49/64	13/16	29/32	1
A₁	7/32	17/64	21/64	3/8	7/16	31/64	35/64	19/32	21/32	49/64	7/8
B	3/8	1/2	9/16	11/16	3/4	7/8	15/16	1	1 1/8	1 1/4	1 7/16
C	3/32	3/32	1/8	1/8	3/16	3/16	1/4	1/4	1/4	1/4	1/4
E	5/64	5/64	1/8	1/8	1/8	5/32	5/32	5/32	5/32	5/32	5/32
H	3/16	15/64	9/32	21/64	3/8	27/64	15/32	33/64	9/16	21/32	3/4
I	3/32	7/64	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
K	1/16	1/16	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32
d	1/16	1/16	3/32	3/32	3/32	1/8	1/8	1/8	1/8	1/8	1/8

DIMENSIONS.

All dimensions in inches.

FINISH.

All heads and nuts to be semi-finish.

MATERIAL.

For all screws and nuts—steel,

Tensile strength, not less than 100,000 lb. per square inch;

Elastic limit, not less than 60,000 lb. per square inch.

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(A.L.A.M. Standards.)

Table A—Screws.

(INCHES)

[Form of thread, United States Standard.]

DIAMETER	PITCH	LENGTH OF THREADED PORTION	DIAMETER OF HEAD ACROSS FLATS	THICKNESS OF HEAD	DIAMETER OF FACING UNDER HEAD	DEPTH OF FACING UNDER HEAD	WIDTH OF SLOT IN HEAD	DEPTH OF SLOT IN HEAD	DIAMETER OF COTTER PIN HOLE
1/4	28	3/8	3/8	3/16	3/8	1/64	1/16	3/32	5/64
5/16	24	15/32	1/2	15/64	1/2	1/64	1/16	7/64	5/64
3/8	24	9/16	9/16	9/32	9/16	1/64	3/32	1/8	1/8
7/16	20	21/32	11/16	21/64	11/16	1/64	3/32	1/8	1/8
1/2	20	3/4	3/4	3/8	3/4	1/64	3/32	1/8	1/8
9/16	18	27/32	7/8	27/64	7/8	1/64	3/32	1/8	5/32
5/8	18	15/16	15/16	15/32	15/16	1/64	3/32	1/8	5/32
11/16	16	1 1/32	1	33/64	1	1/64	3/32	1/8	5/32
3/4	16	1 1/8	1 1/8	9/16	1 1/8	1/64	3/32	1/8	5/32
7/8	14	1 5/16	1 1/4	21/32	1 1/4	1/64	3/32	1/8	5/32
1	14	1 1/2	1 7/16	3/4	1 7/16	1/64	3/32	1/8	5/32

(A.L.A.M. Standards)

Table B—Plain Nuts.

SCREW DIAMETER	THICKNESS OF NUT	DIAMETER ACROSS FLATS	DIAMETER OF FACING	DEPTH OF FACING
$\frac{1}{4}$	$\frac{7}{32}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{32}$
$\frac{5}{16}$	$\frac{17}{64}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{32}$
$\frac{3}{8}$	$\frac{21}{64}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{1}{32}$
$\frac{7}{16}$	$\frac{3}{8}$	$\frac{11}{16}$	$\frac{11}{16}$	$\frac{1}{64}$
$\frac{1}{2}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{64}$
$\frac{9}{16}$	$\frac{31}{64}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{1}{64}$
$\frac{5}{8}$	$\frac{35}{64}$	$\frac{15}{16}$	$\frac{15}{16}$	$\frac{1}{32}$
$\frac{11}{16}$	$\frac{39}{64}$	1	1	$\frac{1}{32}$
$\frac{3}{4}$	$\frac{21}{32}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$\frac{1}{32}$
$\frac{7}{8}$	$\frac{49}{64}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$\frac{1}{32}$
1	$\frac{7}{8}$	$1\frac{7}{16}$	$1\frac{7}{16}$	$\frac{1}{32}$

(A. L. A. M. Standards.)

Table C—Castle Nuts.

SCREW DIAMETER	TOTAL THICKNESS OF NUT	HEIGHT OF CASTLE	DIAMETER OF NUT ACROSS FLATS OF HEX.	DIAMETER OF CASTLE	DIAMETER OF FACING	DEPTH OF FACING	NUMBER OF SLOTS IN CASTLE	DEPTH OF SLOTS IN CASTLE (to round bottom)	WIDTH OF SLOT IN CASTLE	DIAMETER OF COTTER PIN USED
$\frac{1}{4}$	$\frac{9}{32}$	$\frac{3}{32}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{64}$	6	$\frac{3}{32}$	$\frac{5}{64}$	$\frac{1}{16}$
$\frac{5}{16}$	$\frac{21}{64}$	$\frac{3}{32}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{64}$	6	$\frac{3}{32}$	$\frac{5}{64}$	$\frac{1}{16}$
$\frac{3}{8}$	$\frac{13}{32}$	$\frac{1}{8}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{1}{64}$	6	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{3}{32}$
$\frac{7}{16}$	$\frac{29}{64}$	$\frac{1}{8}$	$\frac{11}{16}$	$\frac{11}{16}$	$\frac{11}{16}$	$\frac{1}{64}$	6	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{3}{32}$
$\frac{1}{2}$	$\frac{9}{16}$	$\frac{3}{16}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{64}$	6	$\frac{3}{16}$	$\frac{1}{8}$	$\frac{3}{32}$
$\frac{9}{16}$	$\frac{39}{64}$	$\frac{3}{16}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{1}{64}$	6	$\frac{3}{16}$	$\frac{5}{32}$	$\frac{1}{8}$
$\frac{5}{8}$	$\frac{23}{32}$	$\frac{1}{4}$	$\frac{15}{16}$	$\frac{15}{16}$	$\frac{15}{16}$	$\frac{1}{64}$	6	$\frac{1}{4}$	$\frac{5}{32}$	$\frac{1}{8}$
$\frac{11}{16}$	$\frac{49}{64}$	$\frac{1}{4}$	1	1	1	$\frac{1}{64}$	6	$\frac{1}{4}$	$\frac{5}{32}$	$\frac{1}{8}$
$\frac{3}{4}$	$\frac{13}{16}$	$\frac{1}{4}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$\frac{1}{64}$	6	$\frac{1}{4}$	$\frac{5}{32}$	$\frac{1}{8}$
$\frac{7}{8}$	$\frac{29}{32}$	$\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$\frac{1}{64}$	6	$\frac{1}{4}$	$\frac{5}{32}$	$\frac{1}{8}$
1	1	$\frac{1}{4}$	$1\frac{7}{16}$	$1\frac{7}{16}$	$1\frac{7}{16}$	$\frac{1}{64}$	6	$\frac{1}{4}$	$\frac{5}{32}$	$\frac{1}{8}$

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